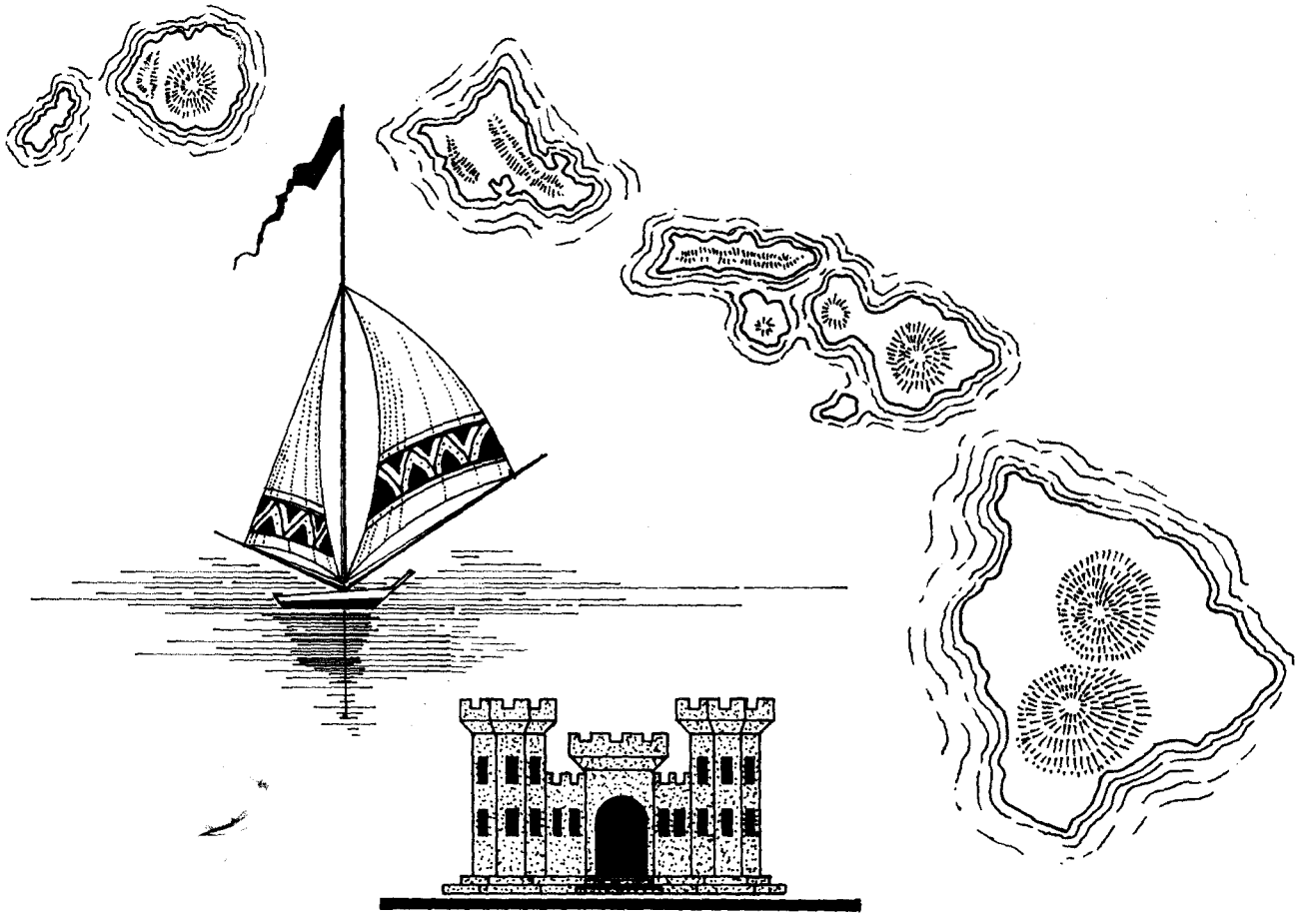
WATER RESOURCES DEVELOPMENT
BY THE
U.S. ARMY CORPS OF ENGINEERS
IN THE
STATE OF HAWAII



U.S. ARMY ENGINEER DIVISION
PACIFIC OCEAN
JANUARY 1967

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For more complete information concerning water resources development discussed in this pamphlet, inquiries should be directed to either of the following offices:

Division Engineer
U.S. Army Engineer Division, Pacific Ocean
Building 96, Fort Armstrong
Honolulu, Hawaii 96813

District Engineer
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Building 96, Fort Armstrong
Honolulu, Hawaii 96813

FOREWORD

This pamphlet is a biennial publication to provide current information on the scope and progress of Federal water resources development within the State of Hawaii by the United States Army Corps of Engineers.

It describes briefly the role of the Corps in planning and building these improvements and includes an explanation of the procedure for initiating and processing these projects. Information includes the status of each project that has been completed, is under construction or under design, or is in the planning and investigation stage.

Since the costs of water resources development projects in Hawaii are divided between the Federal Government and the State of Hawaii and county governments, the public has a primary interest in these projects. The Corps of Engineers therefore encourages the public to become acquainted with these improvements and to enjoy their benefits.

The location of each project is shown on the foldout map at the back of this pamphlet. Additional information on a specific water resources development project and on the responsibilities of the Corps of Engineers may be obtained from the Corps offices listed on the title page.

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INTRODUCTION

FUNCTIONS OF THE CORPS OF ENGINEERS

On June 16, 1775, two days after birth of the Continental Army, General George Washington appointed Colonel Richard Gridley to be his Chief Engineer. From that modest beginning, engineering in the Army has grown vigorously through the years to meet the increasing demands of technological changes. Congress in 1802 authorized the military academy at West Point as an engineer responsibility and set the stage for the use of the Army engineers in early civil works functions, such as the Lewis and Clark Expedition and other explorations, surveying and mapping the vast Western Territory, location and construction of the major railroads, and development of the nation's rivers and harbors.

During the 1820's, under authority of the "commerce clause" of the Constitution which gave Congress the power "to regulate commerce with foreign nations, and among the several states and with the Indian tribes," Congress assigned the Corps of Engineers the responsibility for projects dealing with navigation on the Ohio and Mississippi Rivers. In 1879, Congress created the Mississippi River Commission, thereby establishing flood control in addition to navigation improvements as a basic responsibility of the Corps of Engineers.

Today, the Corps of Engineers is engaged in a continuing water resources development program which amounts to about $1.2 billion a year. This Federal program is assigned by Congress to the Secretary of the Army for accomplishment by the Corps of Engineers. Responsibility for water resources development is shared by many Federal agencies, the 50 States, various regional and local governmental entities, and a broad range of quasi-public and private enterprises.

WATER RESOURCES PLANNING

Recognizing the indivisibility of the water resources in each of the nation's major river basin or geographic region, Congress enacted the Water Resources Planning Act of 1965 to provide for a coordinated effort by all agencies concerned in development of the resources. Other important laws include reorganizing joint Federal-State water resources related activities in recreation, pollution abatement, water supply, and transportation. Under new laws aimed at strengthening wide participation in planning, different formulas govern Federal participation and cost-sharing in beach erosion control, hurricane-flood protection, flood-plain regulation, recreational development and user cost-sharing, water supply, pollution abatement, drainage, flood control, navigation improvements, and in fish and wildlife preservation.

Increased emphasis is being given to the intangible values associated with resource development and construction, such as scenic beauty, architectural design, preservation of the wilderness, and historical and archaeological values. These are not new considerations, but they form a larger factor than ever before in the civic and political acceptance of water resource planning.

In carrying out their broad responsibilities, Federal agencies no longer confine their planning efforts exclusively to Federal construction objectives. Instead, the Federal Government has taken a leading role in encouraging all interests to join in coordinated planning and construction programs so as better to serve all needs of modern society. The effort calls for all agencies concerned to mesh their separate activities into a many-sided but nevertheless unified approach to basically common water problems so that the optimum development and use of our country's limited water resources can be assured.

WATER RESOURCES DEVELOPMENT IN HAWAII

The earliest Corps of Engineers project in Hawaii dates back to 1905, when Congress appropriated funds for the improvement of Honolulu Harbor. At this time, the Honolulu Engineer District was established with First Lieutenant John R. Slattery as the District Engineer.

Since that time, the water resources development program of the Corps in the State of Hawaii has been expanded to include planning, design, construction and maintenance of harbors; planning and constructing flood control and beach erosion control projects; performing flood plain information studies; administering Federal laws to protect and preserve navigable waters; fighting floods and making emergency repairs; and preparing investigation and engineering reports.

Federal water resources development in Hawaii is continually expanding to provide widespread commercial and recreational benefits to island residents as well as to visitors to the State. Major projects completed during the last decade include the bascule bridge (first in Hawaii) and the second entrance channel at Honolulu Harbor; flood control structures on the banks of the Hanapepe River on Kauai, the Wailoa Stream in Hilo, and the Kawainui Swamp and drainage channel in Kailua on Oahu; the State's newest deepwater port at Kawaihae on Hawaii; major rehabilitation of the breakwaters at Kahului Harbor on Maui; and construction of the first Federal-State small boat harbors at Manele Bay on Lanai and at Haleiwa on Oahu.

A multimillion-dollar tsunami protection and navigation improvement project for Hilo Harbor and the city of Hilo is still in the engineering study and design stage. Also in the advance engineering and

design stage are the approved new deep draft harbor at Barber's Point on Oahu, improvements to Kawaihae Harbor on Hawaii and Honolulu Harbor on Oahu, and small boat harbors at Honokahau on Hawaii and at Maunalua Bay on Oahu. Other authorized projects await funds to get into the design stage. Additional studies are underway to determine the advisability and economic feasibility of navigation, flood control, beach erosion control, and multiple-purpose projects desired by non-Federal interests.

ROLE OF THE CORPS OF ENGINEERS IN DEVELOPING WATER RESOURCES IN HAWAII

The Chief of Engineers acts as engineer consultant to Congress. Under his direction is a decentralized organization with Corps of Engineers division and district offices operating as his field staff. In Hawaii, the Honolulu District Engineer operates under supervision of the Pacific Ocean Division Engineer. The District Engineer is responsible for and prosecutes the Federal water resources development program in the State of Hawaii.

The Corps of Engineers does not initiate civil works projects. When local interests feel that a need exists for improved navigation or for flood control or beach erosion control, they may petition their representatives in Congress. A Congressional committee resolution or an Act of Congress may then authorize the Corps of Engineers to investigate the problem and submit a report.

The District Engineer is assigned the study, and he conducts public hearings, conducts engineering surveys and investigations, and estimates the cost and benefits to be expected. The Chief of Engineers then transmits his findings, including the district and division engineers reports and the report of the Board of Engineers for Rivers and Harbors, to the Secretary of the Army.

The report is then transmitted to Congress. If costs exceed the benefits, or if local interests cannot provide the necessary assurances of local cooperation, an unfavorable report is transmitted. If benefits exceed the cost, a favorable report is usually transmitted recommending approval of the project. If authorized by Congress, the project still requires Congressional appropriations to become a reality. The reader will better understand the procedure involved from a study of the illustration on page viii. Considerations which enter into recommendations for project authorization to Congress generally include the findings and determination that benefits will exceed costs, that the project is engineeringly sound and will meet the needs of the people concerned, and that it makes the fullest use possible of the natural resources involved.

NAVIGATION

Beginning with an act approved May 24, 1824, investigations and improvements for navigation and related purposes have been authorized by Congress in a series of River and Harbor Acts. The provisions of these acts, or public laws, are the basis for the policies and procedures for the Corps of Engineers in carrying out its civil functions. Special conditions and local cooperation requirements pertaining to a specific project are included in the act authorizing the project.

Navigation improvement has two aspects which must be considered. It is part of the overall problem of the development of water resources and at the same time is an element of the national transportation problem. The Federal Government is concerned with both aspects.

The primary objective of river and harbor improvements is to assist in the development, conduct and safety of waterborne commerce. This is accomplished by providing adequate waterways so that ships and other water craft can be accommodated safely and expeditiously to provide an economical means of transportation for various types of cargoes. Federal improvements consist of harbors, channels, and anchorages to accommodate both deep draft and light draft shipping, and breakwaters and jetties to provide protection against wave action. Rivers and channels may be improved by clearing and snagging and by dredging.

The Corps of Engineers constructs as well as maintains the Federal river and harbor projects. The cost of these is largely Federal. On recreational projects, non-Federal interests are required to bear about one-half the cost. As used in this pamphlet, total Federal cost includes engineering, design, construction, and maintenance costs of the U. S. Army Corps of Engineers, and costs of navigational aids incurred by the U.S. Coast Guard on harbor projects.

FLOOD CONTROL

Flood control projects are designed to regulate or confine flood flows and thus prevent loss of life and reduce flood damages to business and residences. Flood control may be accomplished by reservoirs (or ponding areas), local protection works, or by combinations of both. Flood control reservoirs or ponding areas provide a place for the temporary detention of excess flow during floods. Local protection is provided by channel enlargement, diversion or realignment; removal of obstructions; construction of levees and walls, channel and bank stabilization, with stone and concrete; or by combinations of these methods. Federal local flood control works in Hawaii are turned over to non-Federal authorities for maintenance.

The Federal interest in flood control was established in 1879 with the appointment of the Mississippi River Commission, when the interrelationship of flood control and navigation became apparent. The Flood Control Act of 1936 extended that interest and contains the basic authority for the Corps of Engineers participation in flood control projects. That act provides: ".....that it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof....." Except for certain small improvements and emergency work, each Federal flood control project must be specifically authorized by Congress.

BEACH EROSION CONTROL

Beach erosion control projects are designed to restore and preserve our coastal shores, to protect public property, and to promote and encourage healthful public recreation. Remedial works or improvements may include beach replenishment or the construction of protective groins and seawalls, or a combination of both, to prevent or reduce damages from storms, tides and wave action. The Federal contribution toward the construction of protective works for non-Federal public shores is limited to a maximum of one-half of the total cost, except in the case of State, county, or other publicly-owned shore parks and conservation areas, where this limitation is increased to seventy per cent. Maintenance of a completed beach erosion control project is a non-Federal responsibility; however, periodic beach nourishment may be construed as "construction" for the purpose of Federal participation when it is determined to be the most suitable and economical remedial measure.

The basic authorities for Corps of Engineers participation in Federal beach erosion control projects are outlined in the River and Harbor Acts of 1930 and 1960. These laws established the policy of Federal assistance in restoration and protection of shores of the United States, its territories and possessions, shores owned by states, cities, or other political subdivisions, and non-public shores.

SPECIAL CONTINUING AUTHORITIES

In addition to the authorizing acts by Congress for specified projects, the Secretary of the Army is empowered under special continuing authorities to accomplish certain projects with funds appropriated annually for such projects, when in the opinion of the Chief of Engineers such work is advisable.

These small project authorities limit the amount of money for any one project at any single location. A project under these authorities is subject to the same requirements of feasibility and economic

justification as a project requiring specific authorization by Congress. Additionally, each project under these authorities must be complete within itself and not commit the Federal Government to any additional improvements to insure successful operation of the project, whether it be for navigation, flood control, or beach erosion control.

Small Navigation Projects. Section 107 of the River and Harbor Act of 1960 (as amended) authorizes the Secretary of the Army to allot funds for construction of small river and harbor improvement projects not specifically authorized by Congress. The Federal (Corps of Engineers) share in each project at any single location shall not exceed $500,000.

Small Flood Control Projects. Section 205 of the 1948 Flood Control Act (as amended) authorizes the Secretary of the Army to allot funds for construction of small projects for flood control and related purposes which are not specifically authorized by Congress. The Federal share in such projects may not exceed $1,000,000 for a project at any single locality.

Small Beach Erosion Control Projects. Section 103 of the 1962 River and Harbor Act (as amended) authorizes the Secretary of the Army to allot funds for construction of small beach erosion control and shore protection projects not specifically authorized by Congress. The Federal share may not exceed $500,000 for each project at any single locality.

Snagging and Clearing (Navigation) Projects. Section 3 of the 1945 River and Harbor Act authorizes the Corps of Engineers to perform emergency work to clear or remove accumulated snags, debris and other obstructions from navigable rivers and harbors.

Snagging and Clearing (Flood Control) Projects. Section 2 of the 1937 Flood Control Act (as amended) authorizes the Corps of Engineers to spend up to $100,000 during any one fiscal year on any single stream or tributary for removal of accumulated snags and other debris and for the clearing and straightening of stream channels when such work is in the interest of flood control.

Emergency Bank Protection Projects. Section 14 of the 1946 Flood Control Act authorizes the Corps of Engineers to spend up to $50,000 during any one fiscal year on any single location to construct bank protection works to prevent damage to highways, bridges, bridge approaches, and other public works endangered by bank erosion.

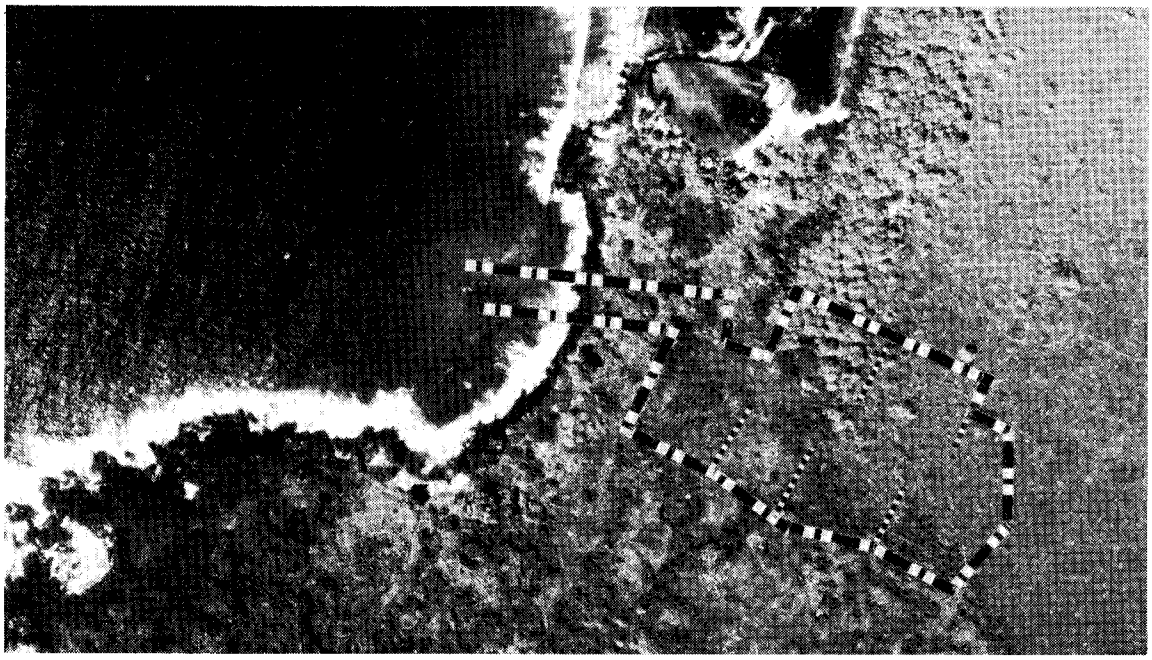
Emergency Flood Control Activities. Public Law 99, 84th Congress, authorizes the Corps of Engineers to engage in flood fighting and rescue operations, and to repair or restore any flood control work threatened or destroyed by flood.

OTHER CORPS OF ENGINEERS ACTIVITIES

Waterborne Commerce Statistics. The Corps of Engineers collects, compiles, and publishes annually, statistics on commercial cargoes and passengers handled by coastal and inland ports. The listing covers every commodity shipped or received via the harbors and waterways during the year. The statistics are highly important in determining the needs for improvement and maintenance of rivers and harbors for commerce and navigation.

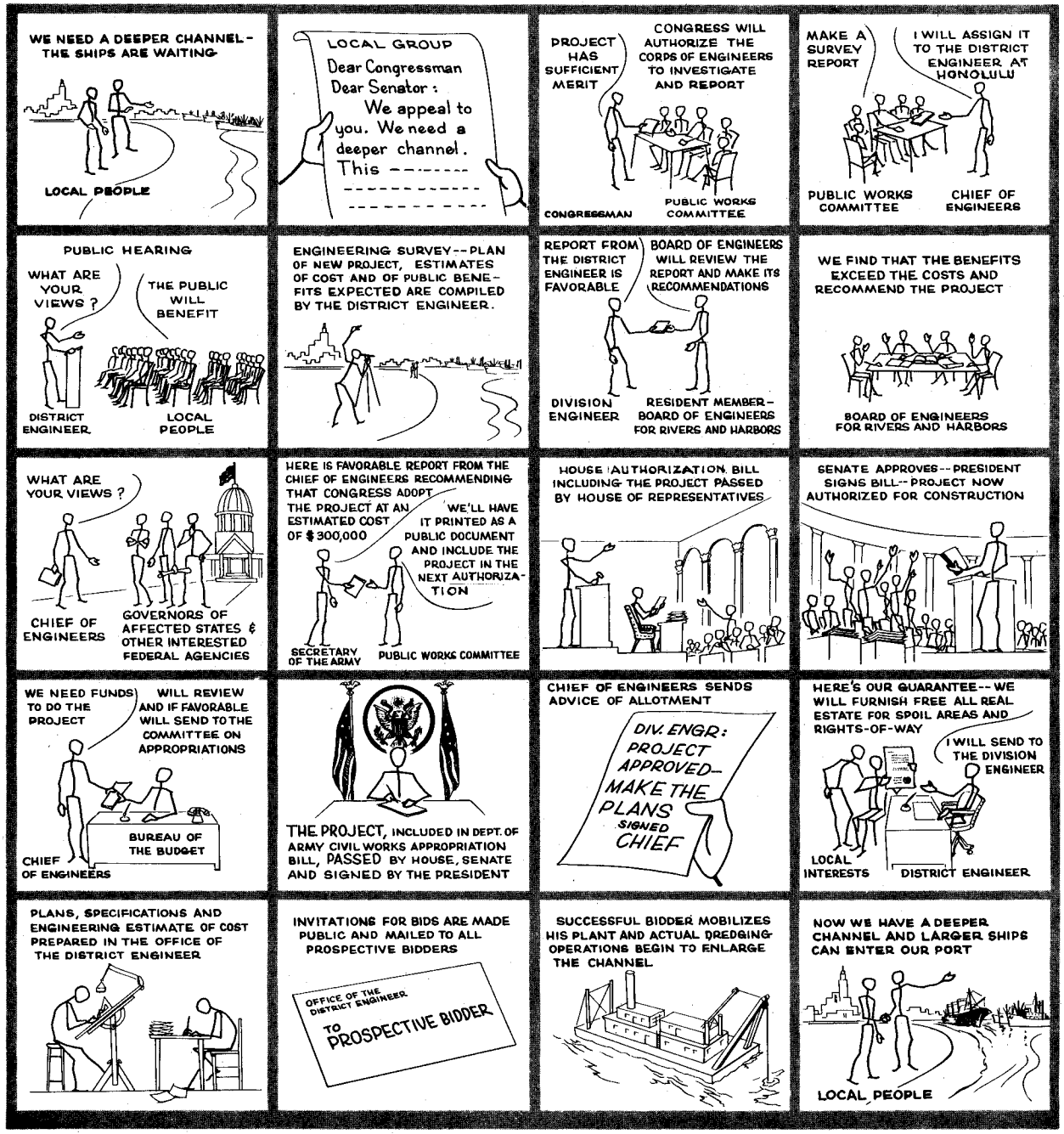
Regulatory Functions. The Corps of Engineers administers laws enacted for the preservation and protection of navigable waters, and include: (a) approving sites and plans for dams, dikes or causeways across navigable waters; (b) granting permits for structures over or in navigable waters; (c) removing sunken vessels or other obstructions to navigation; and (d) establishing danger zones, dumping grounds, restricted areas, fishing areas, and harbor lines.

Flood Plain Information Studies. Section 206 of Public Law 86-645 authorizes the Chief of Engineers, through the Secretary of the Army, to provide information to states and local communities, upon their request, to aid them in providing for use and regulation of flood plain areas. In addition to surveying and mapping the flood plain areas, the Corps of Engineers compiles hydrology and frequency studies to establish the flood damage potential, flood heights, and the extent of inundation of the flood plain area involved. These studies aid local interests in delineating right-of-way lines, river and stream clearance lines, and land use regulations.

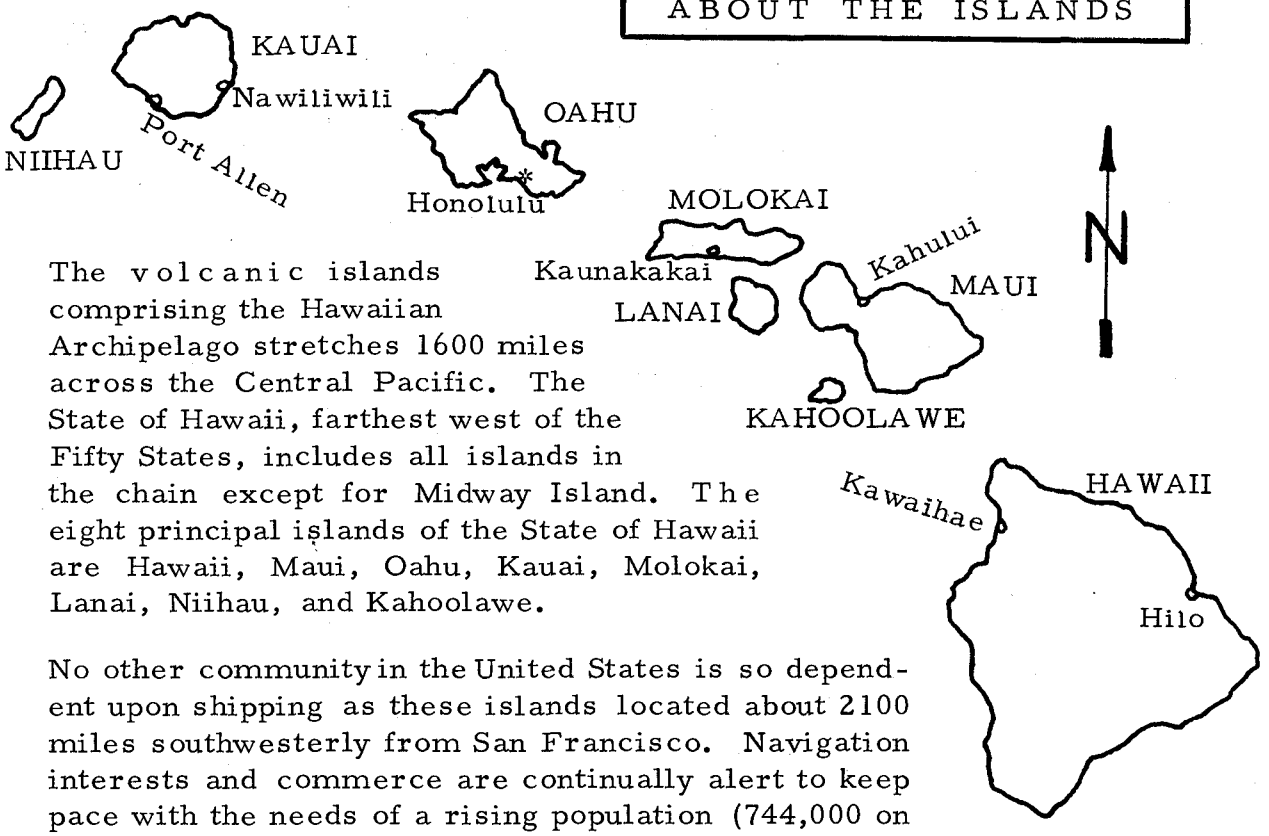


HONOKAHAU SMALL BOAT HARBOR IS UNDER DESIGN (see page 21).

The mechanism by which Civil Works Projects are CONCEIVED, AUTHORIZED and CONSTRUCTED



ABOUT THE ISLANDS



The volcanic islands comprising the Hawaiian Archipelago stretches 1600 miles across the Central Pacific. The State of Hawaii, farthest west of the Fifty States, includes all islands in the chain except for Midway Island. The eight principal islands of the State of Hawaii are Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Niihau, and Kahoolawe.

No other community in the United States is so dependent upon shipping as these islands located about 2100 miles southwesterly from San Francisco. Navigation interests and commerce are continually alert to keep pace with the needs of a rising population (744,000 on July 1, 1966) by putting more ships on the Hawaiian water routes and by improving harbor facilities in the islands. Water sports provide the main recreation in the islands for residents and visitors alike, pointing up the need for improved small boat facilities and for beach erosion control. Federal water resources development projects completed, underway, or under study by the Corps of Engineers are geared to meet the needs of each of the islands.

The island of Hawaii is the youngest and largest in the Hawaiian group and is 4,021 square miles in area. The population on July 1, 1966 was 58,997. Hilo, the county seat, is the second largest city in the state and has the bulk of the island's population with 26,107. The economy of the island is primarily agricultural, with the growing of sugar cane, beef cattle, coffee, and truck crops predominating. Beef cattle are raised on one of the world's largest privately owned ranches. The tourist industry is the major non-agricultural activity with the greatest growth potential and this is reflected in the rapidly expanding resort developments on the Kona coast of the island. Two of the seven deepwater harbors in the State of Hawaii are located on the island of Hawaii at Hilo (page 1) and Kawaihae (page 2).

Maui, second largest island of the group, is 728 square miles in area and had a population of 38,316 on July 1, 1966. Maui is famous for having one of the largest extinct volcanoes in the world, Haleakala, "House of the Sun." Sugar and pineapple are the basic industries of

Maui. However, various types of service industries are gaining in importance since the rapidly expanding tourist industry is becoming a major factor in the island's economy. Lahaina, on the west coast of Maui, is the former capital of the Hawaiian Kingdom. The lone deepwater port serving Maui is at Kahului (page 7). The breakwaters protecting this harbor recently underwent major rehabilitation.

Oahu is the hub of economic and political activity within the state. The island is third in size with an area of 602 square miles and had a population of 611,948 on July 1, 1966. Approximately 70 per cent of this population is in metropolitan Honolulu, the capital of Hawaii. Retail trade, agriculture, manufacturing, and tourist expenditures are of growing importance with service industries showing a predominance of economic importance. Honolulu Harbor, "Crossroads of the Pacific," (page 5) is the principal port in the state and is the major trans-pacific commercial harbor in the islands.

The island of Kauai is 553 square miles in area with a population on July 1, 1966 of 25,545. Its basic industry is sugar and pineapple with the tourist industry growing in importance. Mt. Waialeale is the highest peak on this island and claims fame as one of the wettest spots on earth with an average rainfall of 465 inches annually. Kauai is serviced by two deepwater ports, one at Nawiliwili (page 9) and the other at Port Allen (page 10).

Comprising an area of 259 square miles, Molokai is fifth in size of the islands. The basic industries are pineapple production and small cattle ranches. The population on July 1, 1966 was 5,629. On the northern side of the island is the world-famous Hansen's Disease Settlement of Kalaupapa. A barge harbor at Kaunakakai (page 11) handles water commerce for the island of Molokai.

Lanai, the sixth in size, is 58 miles southeast of Honolulu, Oahu, and is 141 square miles in area. As of July 1, 1966, the population was 2,925. This island is owned by the Dole Pineapple Company and is one of the largest pineapple plantations in the United States. There is no deepwater port on the island of Lanai.

The island of Niihau is off the southwest coast of Kauai. It is privately owned and little developed compared with the other islands in Hawaii. It is 72 square miles in area and had a Hawaiian population of 285 as of July 1, 1966. The basic industry is an island-wide cattle ranch.

The island of Kahoolawe, smallest of the eight islands, is off the southwest coast of Maui. It is 45 square miles in area, and is a barren uninhabited island under military control.

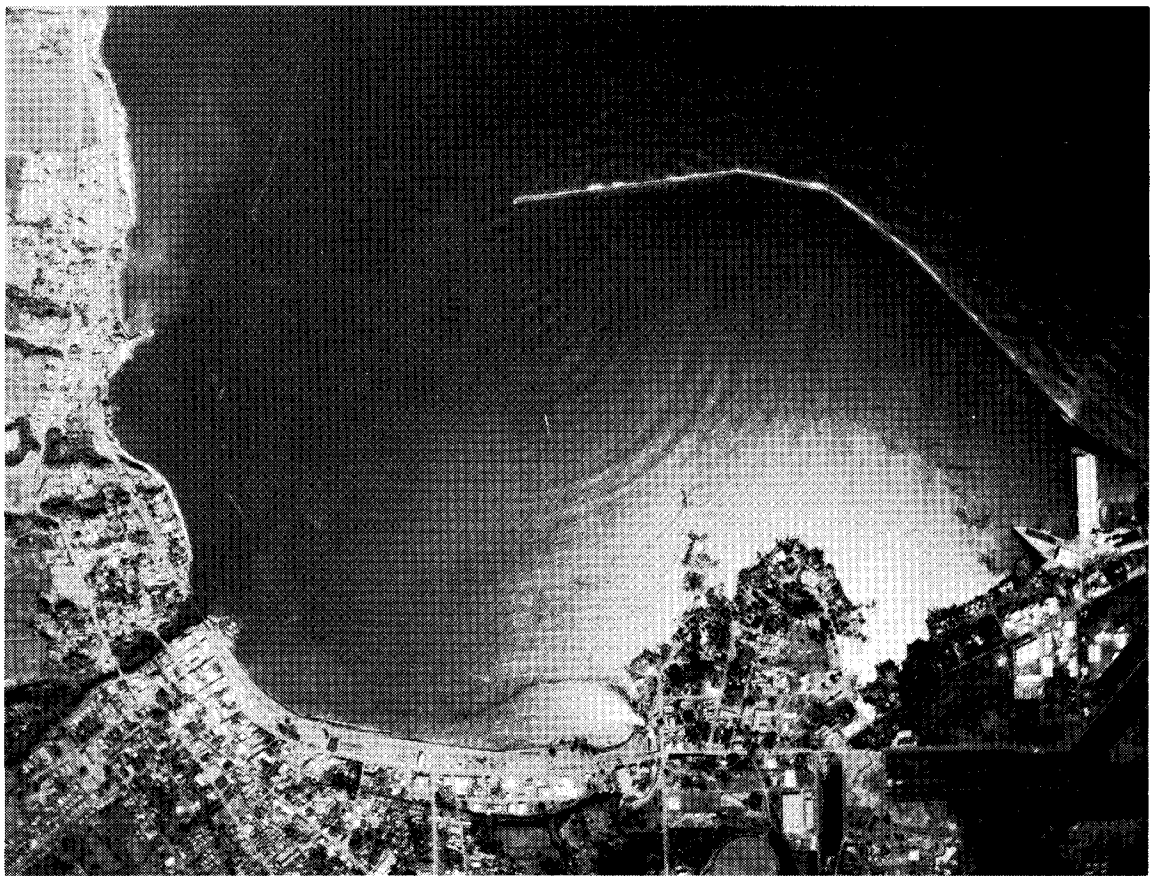
HILO HARBOR, HAWAII

Nestling in crescent-shaped Hilo Bay under the towering slopes of Mauna Loa is Hilo Harbor, the second largest seaport in the state.

The harbor has made Hilo the center of economic activity for the entire island. It is protected by a breakwater 10,170 feet long, has an entrance channel 35 feet deep and a harbor basin 1,400 feet wide, 2,300 feet long and 35 feet deep. Federal improvements to the harbor were completed in 1930. The total Federal funds expended to June 30, 1966, were $6,871,692.

During 1964, 874,490 short tons of cargo passed through Hilo Harbor, and for the 10-year period 1955-1964, an average of 814,870 short tons were handled annually.

The Corps of Engineers has completed extensive model tests and studies to determine the most practical plan for tsunami protection and navigation improvements which have been authorized for Hilo Harbor (see page 20).



HILO HARBOR, ONE OF TWO PORTS ON THE ISLAND OF HAWAII.

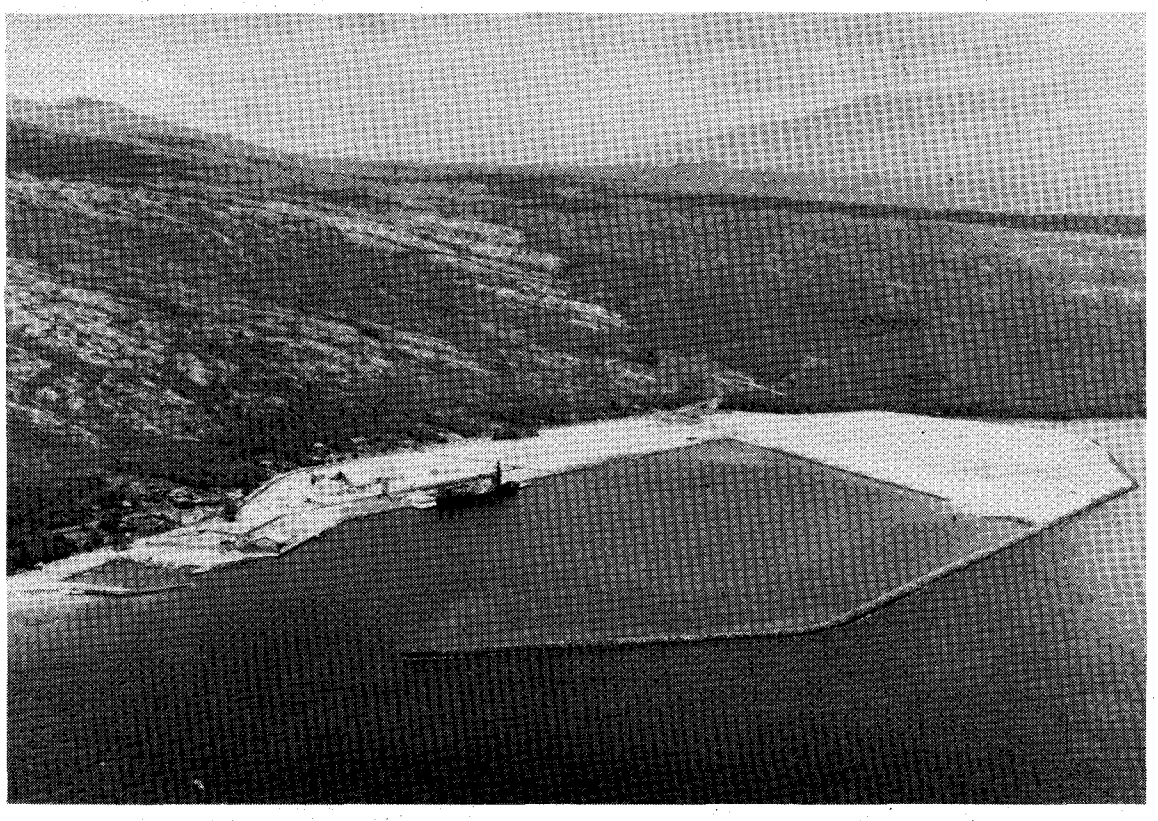
KAWAIHAE HARBOR, HAWAII

On the north end of Kawaihae Bay on the northwest coast of the island of Hawaii, near the resort areas, the island's second deepwater port was constructed in 1959. This port, about 85 nautical miles northeast of Hilo Bay, was considered essential to the present needs and the future development of the communities of North and West Hawaii.

The harbor has an entrance channel 400 feet wide, 2,900 feet long, and 40 feet deep. A harbor basin is also provided that is 1,250 feet square and 35 feet deep and is protected by a breakwater 2,650 feet long and by a filled area protected by 3,335 feet of heavy stone revetment. Additional dredging at the entrance to make navigation easier was completed in 1962. Total Federal funds expended at Kawaihae Harbor as of June 30, 1966 are $4,729,998.

In 1964, a total of 176,320 short tons of cargo passed through the Kawaihae Harbor. For the five-year period 1960-1964, an average of 133,030 short tons of cargo were handled annually.

Modifications to Kawaihae Harbor which include widening the seaward portion of the entrance channel and enlarging the harbor basin (see page 20) were authorized by Congress in October 1965.



MODIFICATIONS FOR KAWAIHAE HARBOR ARE UNDER DESIGN.

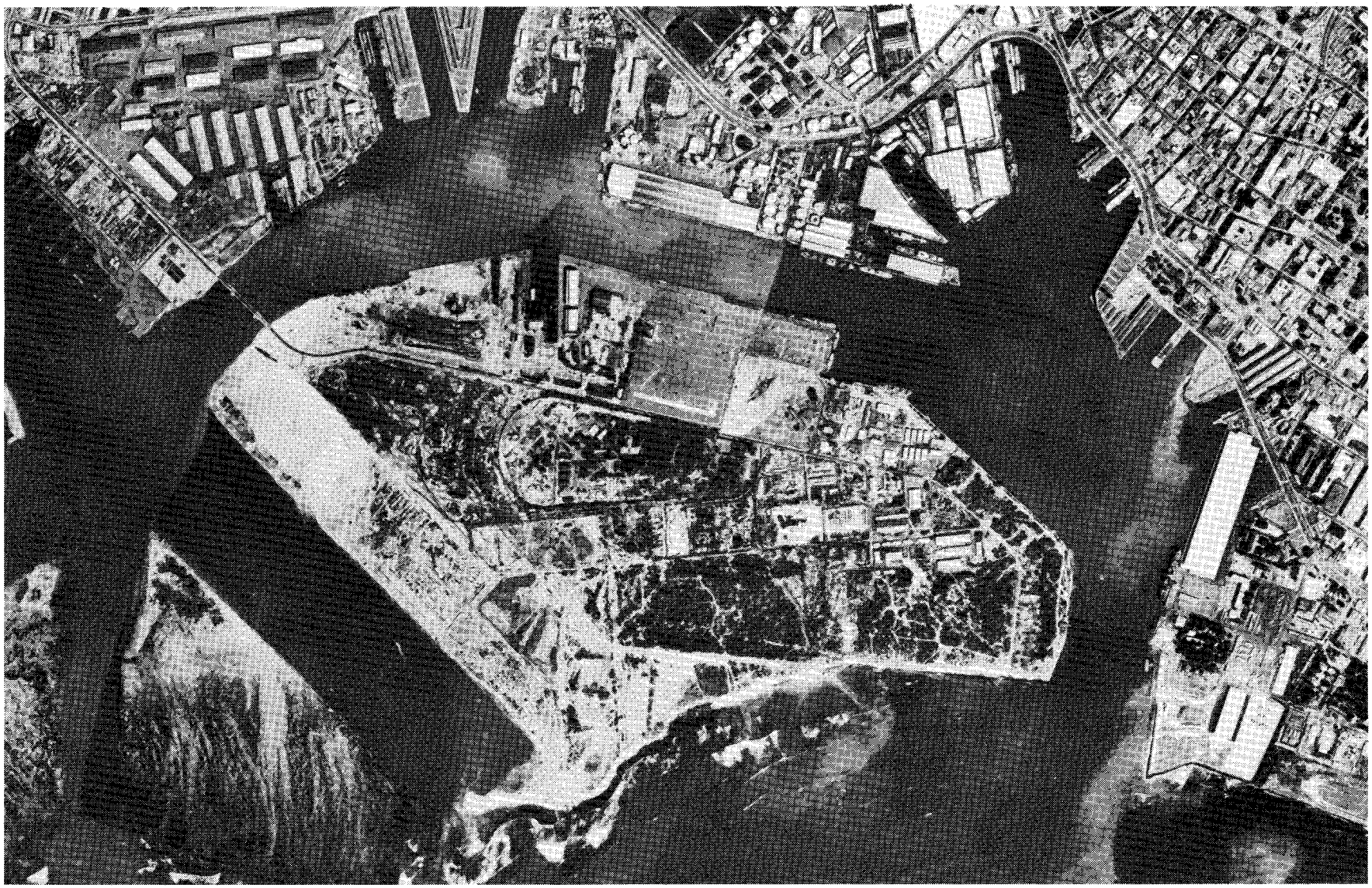
HALEIWA SMALL BOAT HARBOR, OAHU

The site of this first Federal-State small boat harbor on the island of Oahu is at the west end of Waialua Bay near the mouth of the Anahulu River on the northern end of the island.

The Federal portion of the project, completed during 1966, consists of an entrance channel 610 feet long, 120 feet wide, 12 feet deep; a revetted mole 1200 feet long; and a diversion channel 520 feet long and 80 feet wide. Total cost of construction as of December 31, 1966 is $495,000, of which $300,000 is Federal (includes $5,000 for aids to navigation) and $195,000 non-Federal.

Construction of berths, docking and onshore facilities by the State of Hawaii will start in 1967. When fully completed, the small boat harbor will accommodate 220 small craft.

HALEIWA SMALL BOAT HARBOR AND
HALEIWA BEACH PROTECTION PROJECT IN WAIALUA BAY.
(Beach erosion control project is described on page 18)



HONOLULU HARBOR, PRINCIPAL PORT FOR THE STATE OF HAWAII.

HONOLULU HARBOR, OAHU

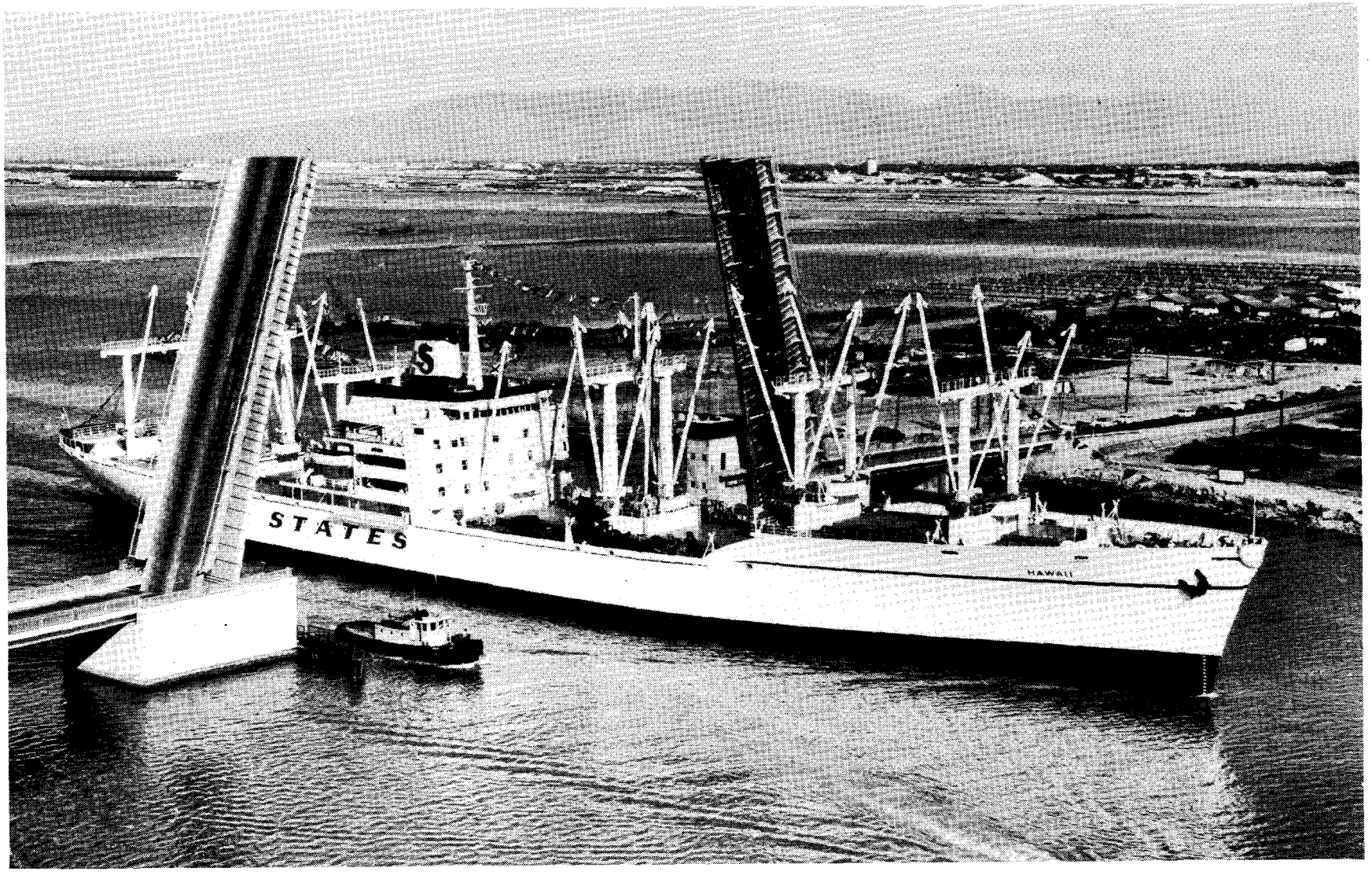
Located on the south coast, it is the largest civil port in Hawaii and the only commercial deepwater port on Oahu. Now greatly expanded beyond its original natural site, the harbor fronts the downtown district of metropolitan Honolulu. Roughly crescent shaped, Honolulu Harbor is approximately 2 miles long and varies in width from 600 feet to about 2,900 feet. This protected area, sheltered from the open sea by Sand Island and adjacent coral reefs, affords an excellent all-weather haven for transpacific and interisland shipping.

The Federal portion of Honolulu Harbor consists of:

- An east entrance channel (Fort Armstrong Channel) 500 feet wide by 4,000 feet long, 40 feet deep.
- An eastern harbor basin (Honolulu Harbor proper) about 1,520 feet wide and 3,300 feet long, 35 feet deep.
- A western harbor basin (Kapalama Basin) 1,000 by 3,400 feet, 35 feet deep.
- A connecting channel (Kapalama Channel) between the two basins, 1,000 feet wide for the first 1,000 feet of its easterly end, thence 600 feet wide for the remaining 2,400 feet, all 35 feet deep.
- A slip 1,000 feet long at the easterly side of Pier 39 at Kapalama Basin, 35 feet deep.
- A second, curved extrance channel (Kalihi Channel) extending 10,300 feet seaward from Kapalama Basin, varying in width from 451 feet at its inner end to a maximum of 960 feet in the emergency turning basin in Keehi Lagoon, and thence 400 feet for the remaining length seaward, all 35 feet deep.
- A double-leaf bascule drawbridge (Slattery Bridge) with a clear horizontal opening of 250 feet, across the inner end of Kalihi Channel connecting Sand Island and the Honolulu shoreline.

During 1964, 213,000 passengers embarked at this major port, and the tonnage totaled 4,755,740 short tons. An average of about 4,264,900 short tons of cargo passed through this harbor annually during the ten-year period 1955-1964.

The first Federal improvement for Honolulu Harbor was completed in 1907, and the most recent improvements--dredging the second entrance channel and construction of the bascule bridge across the channel--were completed in 1962. Total Federal funds expended for improvements to Honolulu Harbor to the end of calendar year 1966 are $9,471,619.



THE SLATTERY BRIDGE, FIRST DRAWBRIDGE IN HAWAII,
SPANS THE SECOND ENTRANCE CHANNEL TO HONOLULU HARBOR.

HONOLULU HARBOR (Continued)

Modifications to Honolulu Harbor which provide for deepening the main entrance channel and the main harbor basin and Kapalama Channel were authorized by Congress in October 1965. These modifications are now in the advance engineering and design phase (see page 22).

KAHULUI HARBOR, MAUI

This harbor is the sole deepwater port serving Maui and is on the north coast of the island at the apex of the plain separating West Maui from East Maui. The towns of Wailuku and Kahului are adjacent to the port. Shipping provided 787,345 short tons of commerce for Maui during 1964, with a ten-year average tonnage of 668,503 short tons annually.

The Federal harbor project was completed in December 1931. Subsequently, the harbor basin was enlarged in March 1962, and the breakwaters underwent major rehabilitation which was completed in 1966. Total Federal funds expended to the end of calendar year 1966 totaled $6,860,166, and non-Federal funds totaled $20,017.

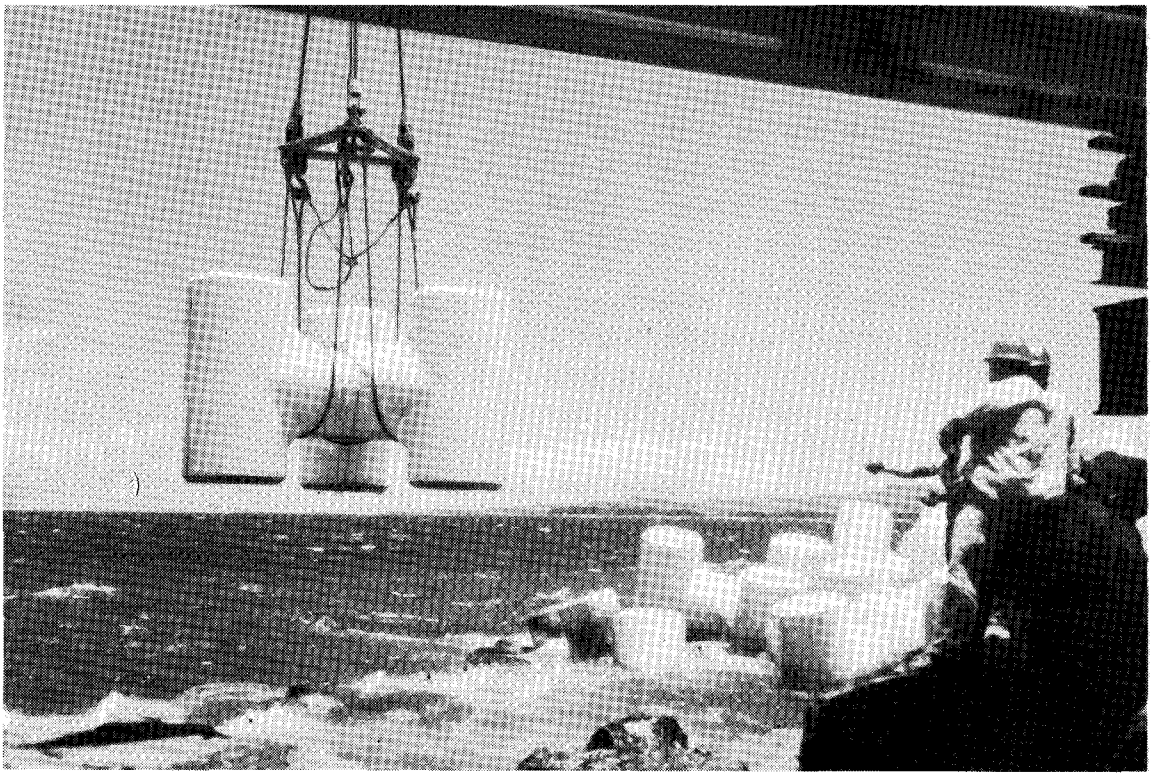
The Federal portion of the harbor now consists of:

- An east breakwater 2,850 feet long.
- A west breakwater 2,390 feet long.
- A harbor basin 2,000 feet long, 35 feet deep, with a maximum width of 1,450 feet.
- An entrance channel, 600 feet wide between the breakwaters, 35 feet deep.

Major rehabilitation of the seaward portions of the Kahului Harbor breakwaters was completed in 1966. Repair of the damaged breakwaters with 35-ton and 50-ton tribar armor units was performed in accordance with information obtained from study of extensive model testing for stability against storm waves. A total of 827 35-ton tribars and 43 50-ton tribars were placed on the east breakwater. The 35-ton tribars placed on the seaward side of the breakwater were backed with concrete ribs which were cast on top of the existing breakwater crest. The 50-ton tribars were placed on the inboard quadrant of the east breakwater head. The west breakwater head was armored with 181 35-ton tribars and 173 50-ton tribars. All tribars were cast at the project site.

A surveillance program is underway to determine from prototype data the effectiveness of tribars as breakwater armor units.

KAHULUI HARBOR BEFORE REHABILITATION OF BREAKWATERS.



PLACEMENT OF 35-TON TRIBARS ON THE EAST BREAKWATER.

NAWILIWILI HARBOR, KAUAI

Nawiliwili Harbor is in Nawiliwili Bay on Kauai's southeast coast. It was developed by dredging a harbor basin and by constructing a rubblemound breakwater, both completed in 1930. Major repair to the breakwater (using tribars for the first time in the State of Hawaii) was completed in 1959, and the entrance channel was deepened and the basin enlarged in 1960.

The Federal portion of this harbor now consists of a breakwater 2,150 feet long; an entrance channel 2,400 feet long, 600 feet wide, and 40 feet deep; and a harbor basin 1,540 feet by 1,950 feet and 35 feet deep. Total funds expended to the end of calendar year 1966 are $4,148,242, of which $3,914,981 is Federal cost and $233,261 is non-Federal cost.

Commerce at Nawiliwili Harbor in 1964 amounted to 418,960 short tons, and the average annual tonnage for the past 10 years was 402,940 short tons.

A survey is authorized to consider the advisability of modifying the harbor to accommodate larger vessels of the C114 class (refer to page 38).

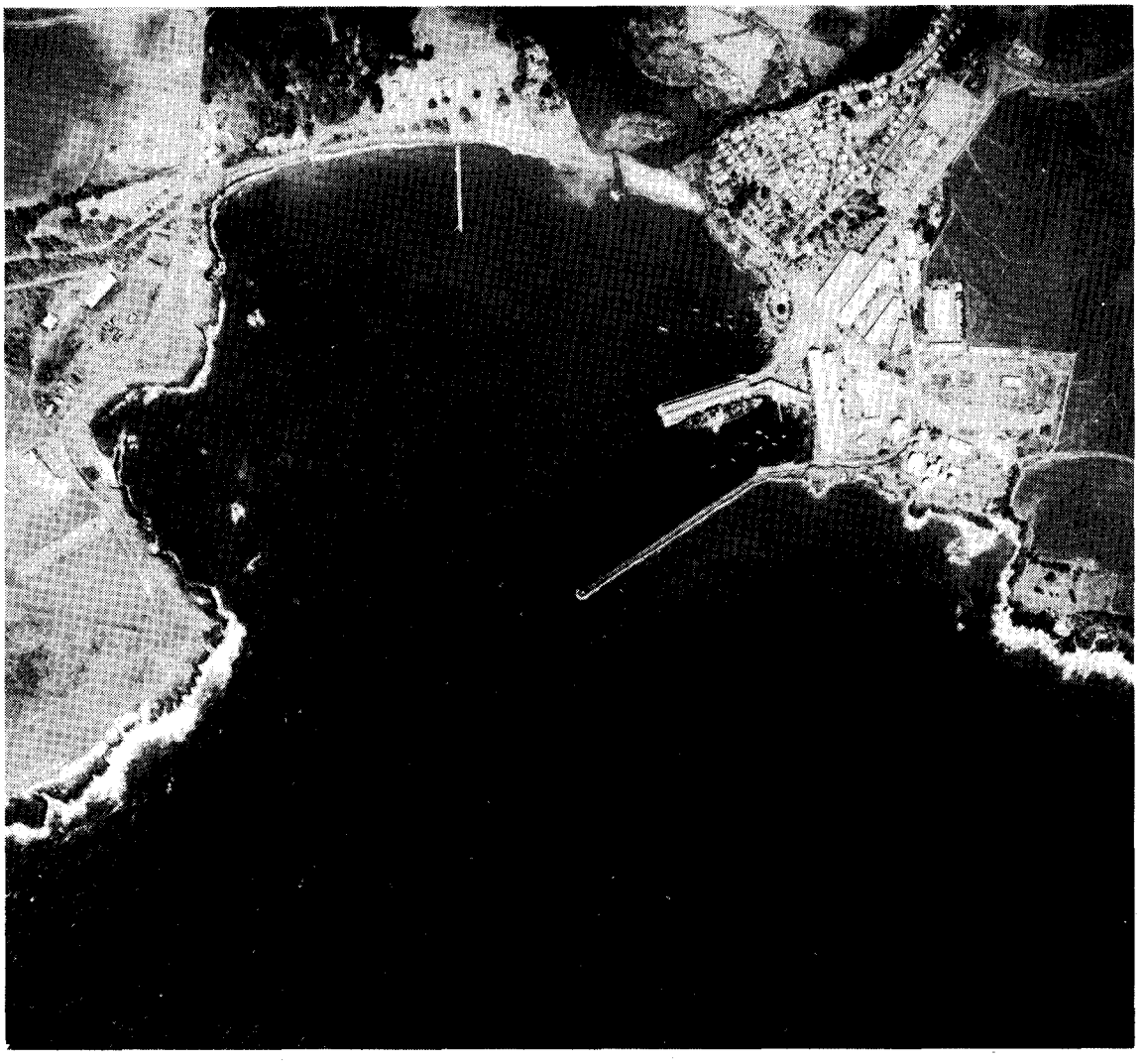
NAWILIWILI HARBOR IS ONE OF TWO PORTS SERVING KAUAI.

PORT ALLEN HARBOR, KAUAI

Port Allen is on the southeast side of Hanapepe Bay on the south coast of Kauai. Completed in 1948, the Federal portion of the harbor consists of a 1,200-foot breakwater; an entrance channel 500 feet wide and 35 feet deep; and a harbor basin 1,200 feet wide, 1,500 feet long, and 35 feet deep. Total funds expended to the end of calendar year 1966 are $1,174,019, of which $974,019 is Federal cost and $200,000 is non-Federal cost.

Commerce at Port Allen in 1964 totaled 130,160 short tons, with a ten-year average annual tonnage of 137,500 short tons.

A survey is now underway to determine the advisability at this time of modifying the existing Federal project (see page 36).



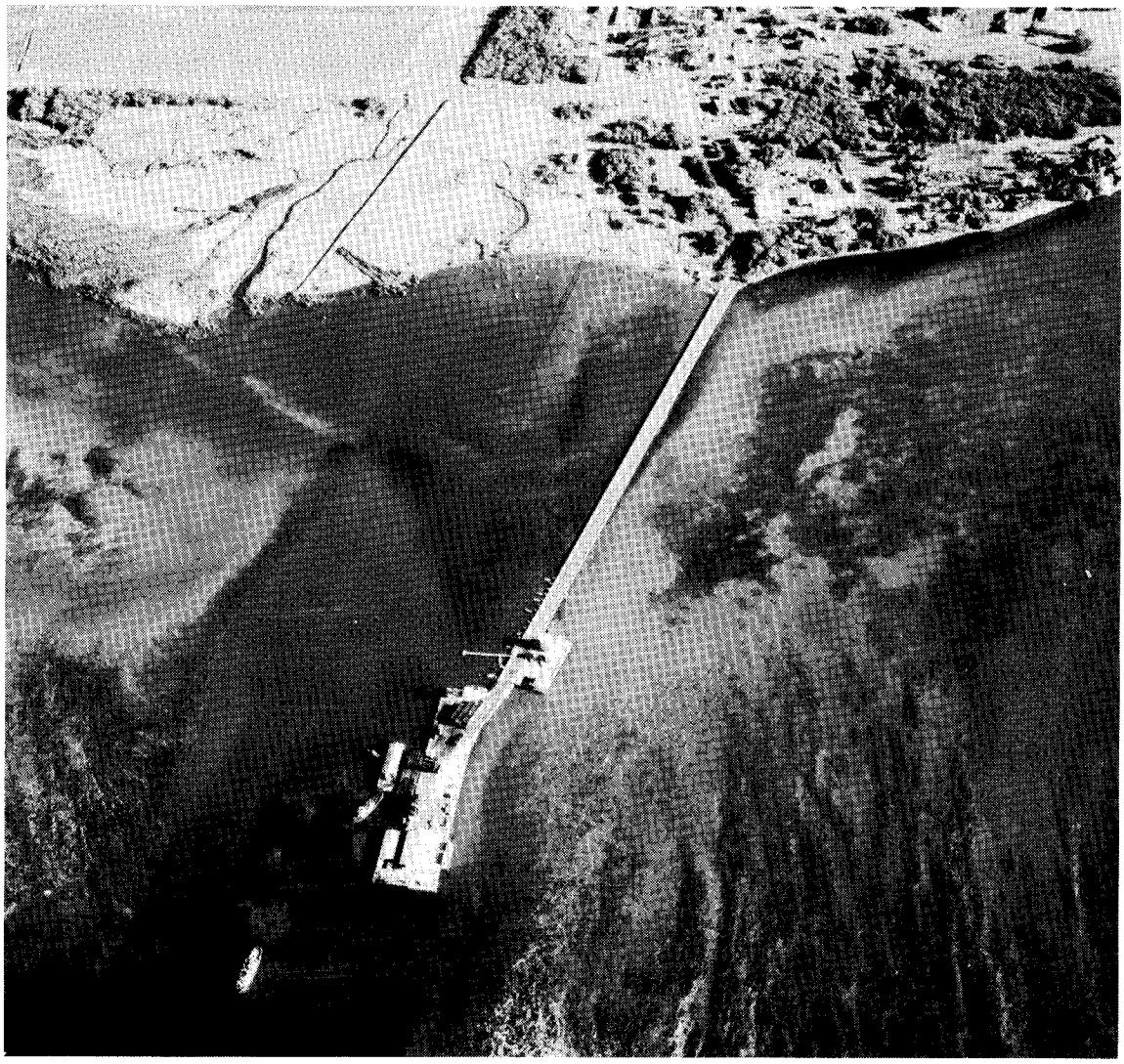
PORT ALLEN IS IN HANAPEPE BAY ON SOUTH KAUAI.

KAUNAKAKAI HARBOR, MOLOKAI

Located 56 miles southeast of Oahu and 9 miles northwest of Maui, Kaunakakai Harbor serves as the major port for Molokai. The Federal project completed in 1934 consists of a dredged channel and barge harbor basin 1,500 feet long, 600 feet wide, 23 feet deep. Total Federal funds expended to the end of calendar year 1966 are $194,971.

Commerce through the port totaled 292,546 short tons in 1964, with a ten-year average tonnage of 265,080 short tons annually.

A Federal deepwater harbor project has been authorized for Kaunakakai Harbor. Construction has not started (see page 24).



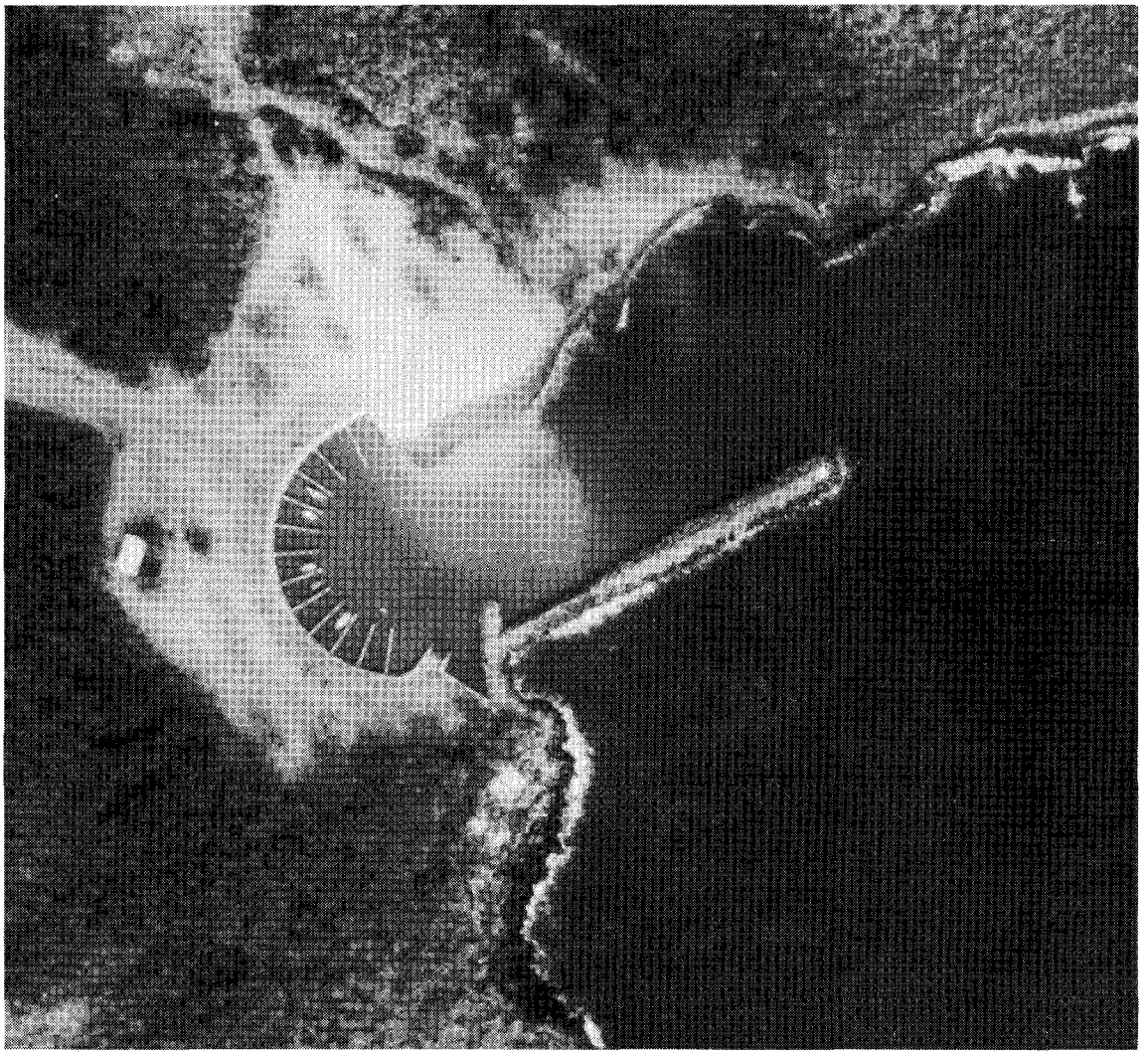
KAUNAKAKAI BARGE HARBOR.
KAUNAKAKAI STREAM IS AT THE UPPER LEFT.

MANELE BAY SMALL BOAT HARBOR, LANAI

Construction of a small boat harbor in Manele Bay on the south coast of Lanai was completed in 1965. This is the first Federal-State small boat harbor constructed in the State of Hawaii.

Federal construction consisted of a 470-foot extension to an existing 110-foot stub breakwater, an entrance channel 150 feet wide, and a main access channel and maneuvering area 8 feet deep. The protected harbor area of 4.6 acres when fully developed will accommodate approximately 130 small craft.

The total cost of the project is $743,000, of which $372,000 is Federal and $371,000 is non-Federal.



SMALL BOAT HARBOR AT MANELE BAY, FIRST IN HAWAII CONSTRUCTED WITH JOINT FEDERAL AND STATE FUNDS.

WAILOA STREAM AND TRIBUTARIES, HAWAII

Wailoa Stream and its tributaries are on the northeasterly side of the island of Hawaii, and in the Waiakea section of the city of Hilo. The drainage basin comprises about 19.6 square miles and extends from about the 2,500-foot elevation on Mauna Loa's volcanic slopes to the city of Hilo and thence to the ocean through Waiakea Pond and Wailoa River.

The flood control project was completed in August 1965 and provided for:

- Clearing the upper reaches of Waiakea and Kawili Streams.
- Construction of a combination 355-foot long diversion channel and 88-foot levee to divert the flow of Kawili Stream into Waiakea Stream.
- A combination channel 333 feet long and levee 331 feet long to divert the combined flows of Waiakea and Kawili Streams into a long and narrow swale area.
- A combination channel 1,100 feet long and levee 800 feet long to protect the University of Hawaii Hilo Campus Dormitory.
- A diversion levee 325 feet long to divert the flows from the swale area to a new excavated channel 4,680 feet long.
- Earth levees totaling 3,880 feet along the excavated channel.
- A new 122-foot concrete box culvert, and an 80-foot concrete bridge constructed with non-Federal funds.

The total cost of the project is $1,744,900, of which $1,044,900 is Federal cost and $700,000 is non-Federal.

WAILOA STREAM DRAINAGE BASIN INCLUDES HILO.

WAILOA STREAM AND TRIBUTARIES (Continued)

The completed project was turned over on September 15, 1965 to the County of Hawaii for operation and future maintenance. Since completion of the project, flood damages prevented are estimated at $117,000.

KAWAINUI SWAMP, OAHU

FLOOD PROTECTION FOR KAILUA COMMUNITY INCLUDES LEVEE ALONG KAWAINUI SWAMP AND IMPROVED ONEAWA CHANNEL.

KAWAINUI SWAMP, OAHU

Kawainui Swamp is on the northeast side of Oahu and on the outskirts of the rapidly growing community of Kailua. The Federal flood control project completed in October 1966 provided for:

- Improvement of Oneawa Channel from the upstream swamp entrance to the ocean, 9,100 feet long, with minimum bottom width of 80 feet and minimum depth of 6 feet.
- A 50-foot stub groin with riprap protection at the outlet of the channel to the ocean.
- A 6,800-foot long levee with crest elevation of 9.5 feet between the swamp and the town of Kailua.
- A ponding area in the swamp for detaining flood waters.
- Graded and grassed levees and general improvements to afford esthetic values.

The total cost of the project is $2,533,700, of which $1,265,100 is Federal cost and $1,268,000 is non-Federal.

Construction of the flood protection project started in June 1964. Numerous rainstorms delayed and hampered work, which resulted in extending the construction period. The project was turned over to the City and County of Honolulu for operation and future maintenance. During the short period since completion of the project in October 1966, flood damages prevented are negligible.

CHANNEL WIDENING AND IMPROVEMENTS ON ONEAWA CHANNEL.

HANAPEPE RIVER, KAUAI

The Hanapepe River begins in Alakai Swamp near the summit of 5,080-foot high Mt. Waialeale. The project to control its flooding was constructed in two phases. The first phase consisted of a left bank levee and floodwall 2,200 feet long which was completed in December 1959. The second phase, consisting of a right bank levee 4,465 feet long, was completed in August 1963. The total cost of the project is $796,100, of which $785,000 is Federal cost and $11,100 is non-Federal.

During 1966, both right and left bank levees were increased in height to provide adequate freeboard for major floods.

The project provides flood protection for the residential and business center of Hanapepe on the left bank, and for the predominantly agricultural lands on the right bank. Since completion of the project, flood damages prevented are estimated at $300,000.

KAUNAKAKAI STREAM, MOLOKAI

A small levee project was completed in December 1950 for flood control of Kaunakakai Stream located on the south central coast of Molokai.

Constructed under the special continuing authority for small flood control projects, the Federal project provided for an enlarged stream channel flanked by earth levees with rock facing. The left bank levee is 3,800 feet long extending from the bluff adjacent to the stream and north of the town of Kaunakakai, thence to the ocean. The right bank levee is 1,050 feet long extending downstream from the opposite bluff.

Total Federal funds expended to the end of calendar year 1964 are $73,748. The project provides flood protection for more than half the town of Kaunakakai and since completion has prevented damages estimated at $185,000.

Kaunakakai Stream is pictured in relation to the existing Kaunakakai Harbor on page 11.

PART OF FLOOD CHANNEL FOR WAILOA STREAM & TRIBUTARIES.
(Project described on pages 13 and 14)

BEACH EROSION CONTROL PROJECTS COMPLETED

HALEIWA BEACH, OAHU

The authorized plan of improvement for this beach on the north coast of Oahu and adjacent to the small boat harbor at Haleiwa provides for an offshore breakwater, a groin, and placement of beach core material overlain by a beach sand blanket. These improvements were completed by the State of Hawaii in 1965. The estimated project cost is $420,000, of which $252,000 is Federal cost and $168,000 is non-Federal cost.

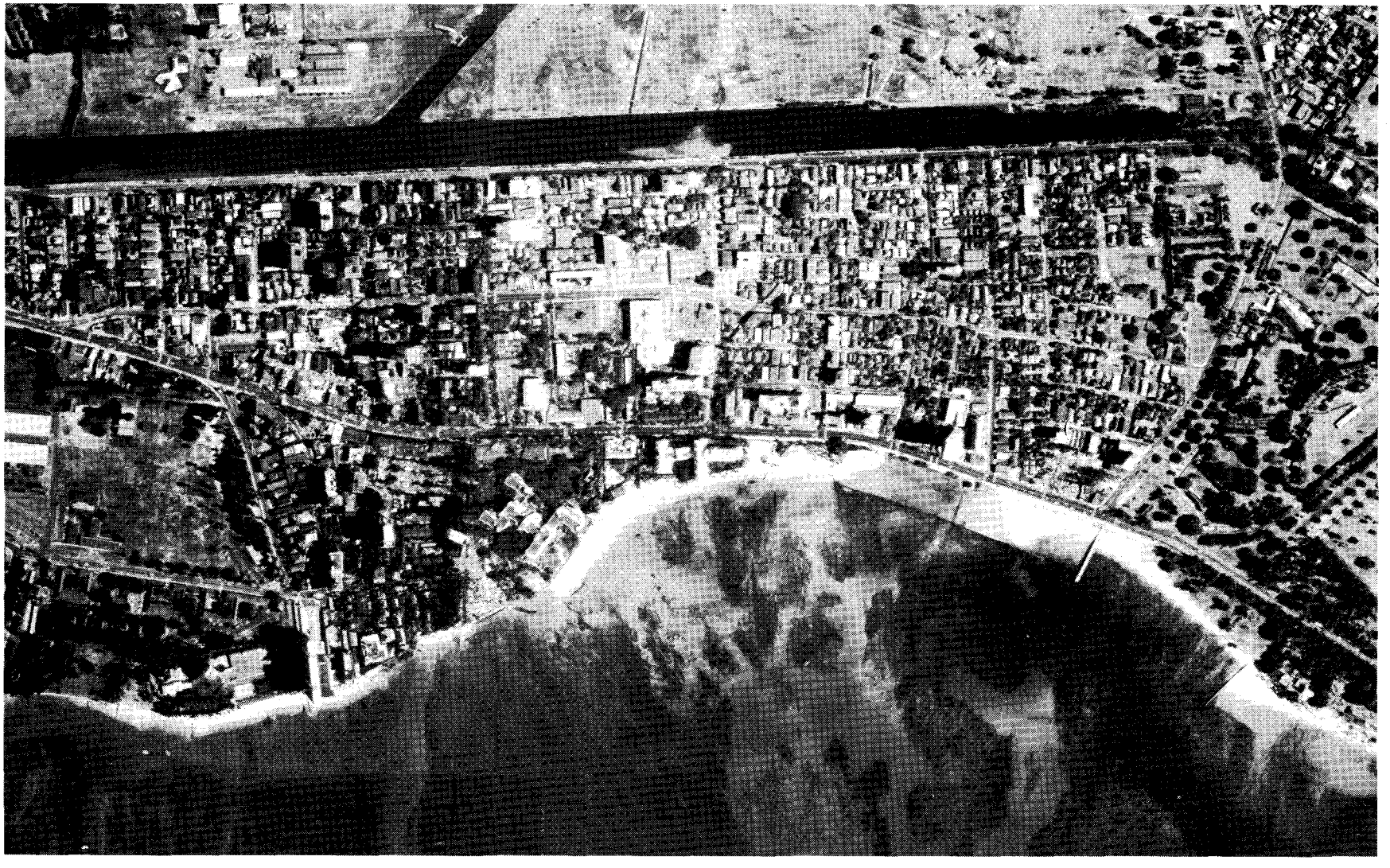
The project has been authorized by Congress and reimbursement to the State of Hawaii for the Federal share of the cost is pending.

The improved beach can be seen in the photograph of Waialua Bay on page 3 showing the small boat harbor and beach projects.

WAIKIKI BEACH, OAHU

Early in 1948, the Territory of Hawaii requested a cooperative beach erosion control study at Waikiki Beach to determine a method of protecting shore facilities, reducing erosion, and restoring usable beach areas. The cooperative report prepared in 1950 recommended placement of 385,000 cubic yards of sand fill on the shore from the Natatorium to Fort DeRussy to widen the beach widths of 75 to 150 feet. Also recommended was construction of a 1200-foot terrace wall, two groins, and appurtenant drainage facilities. The project was initiated by the Territory of Hawaii in 1951 and completed in 1959 for the publicly owned shores at a cost of $643,068, of which $214,356 was reimbursed by Federal funds.

The Corps of Engineers has recommended a beach erosion control project for Waikiki Beach which will supersede the authorized project (see page 30).



A NEW BEACH EROSION CONTROL PROJECT HAS BEEN AUTHORIZED FOR WORLD-FAMOUS WAIKIKI BEACH.

NAVIGATION PROJECTS UNDER DESIGN

HILO HARBOR TSUNAMI PROTECTION AND NAVIGATION IMPROVEMENT, HAWAII

The portion of the city of Hilo which fringes Hilo Bay and Hilo Harbor has frequently experienced tsunamis (commonly misnamed tidal waves). Since 1818, 42 tsunamis of varying magnitudes have struck the Hawaii area; seven of them have had damaging effects. The 1946 tsunami devastated the Hilo area, causing property damage estimated at $26 million. Ninety-six people lost their lives during this disaster, and many more sustained injuries. The May 1960 tsunami caused damages estimated at $22 million and killed 61 people.

In 1962, after the disastrous tsunami of 1960, a plan of improvement to protect the city of Hilo against tsunamis and to improve the navigation conditions in Hilo Harbor (page 1) was authorized for construction. The authorized but uncompleted portion provides for a west breakwater 4,000 feet long; a 400-foot extension to the existing 10,070 east breakwater, and a land dike 6,600 feet long.

In 1965 and 1966, extensive model studies and tests were conducted by the Corps of Engineers at its Waterways Experiment Station in Vicksburg, Miss., and at the Look Laboratory of Oceanographic Engineering in Honolulu to determine the most practical plan of improvement for tsunami protection and navigation improvement. Related field studies were conducted in the Hilo area, among which were test quarries, and land and subsurface investigations. The report on the Hilo Harbor Model and design studies on the project will be completed in 1967.

KAWAIHAE HARBOR (MODIFICATIONS), HAWAII

The authorized plan of modification to this Federal deepwater harbor (page 2) serving the northwest coast of the island of Hawaii provides for:

- Widening of the seaward 1,200 feet of the harbor entrance channel along its northerly side by 100 to 120 feet.
- Widening of the seaward side of the harbor basin by a maximum of 200 feet to create an additional maneuvering basin area of approximately 9.5 acres.
- Lengthening the harbor basin on its south side by a maximum of 500 feet to create an additional maneuvering area of approximately 8.5 acres.
- Constructing a rubblemound breakwater extension, about 750 feet long, from near the head of the present structure seaward along the southerly side of the entrance channel

but only if the effectiveness of such a structure is first clearly demonstrated by hydraulic model tests.

The project cost is estimated at $2,280,000, of which $2,260,000 is Federal cost and $20,000 is non-Federal cost. The benefit-cost ratio is 2.1.

Model testing is presently underway to study wave action in the existing and improved harbor and for the authorized associated small boat harbor (see below). Hydraulic model studies to determine the effects of the authorized modifications on the wave climate in the harbor basin and the need for additional protective structures were conducted at the Waterways Experiment Station in 1966.

KAWAIHAE SMALL BOAT HARBOR, HAWAII

This project will be dredged in the shallow reef area off the south end of the main deepwater harbor. When completed, it will accommodate about 300 based craft. The Federal portion of the authorized harbor will provide a main access channel 900 feet long, 80 to 100 feet wide, with an outer depth of 10 feet and an inner depth of 8 feet, and a protective wave absorber and mole. The project cost is estimated at $57,000, of which $31,000 is Federal cost and $26,000 is non-Federal. The benefit-cost ratio is 16.2. Model testing is presently underway to study wave action in the existing harbor and entrance channel and for the deepwater harbor modifications (see above) and the small boat harbor.

HONOKAHAU SMALL BOAT HARBOR, HAWAII

A small boat harbor has been authorized for construction in Honokahau Bay, located about midway on the west coast of the island of Hawaii. The shoreline site (photograph on page vii) of the recommended project faces a small inlet about 4 miles southeast of Keahole Point, about 28 nautical miles northwest of Kona Airport. Model studies were made of Honokahau Harbor. The Federal portion of the project under the present plan will provide an entrance channel 840 feet long and 120 feet wide with depths of 20 and 15 feet; a main access channel 730 feet long, 120 feet wide, 12 feet deep; a service channel 200 feet long, 75 feet wide, 15 feet deep; wave absorbers along both sides of the entrance channel; and a wave trap at the shoreward end of the entrance channel. The harbor, when fully developed, will have a protected harbor basin of 17.5 acres and will be able to accommodate about 420 boats. The project cost is estimated at $1,271,000, of which $695,000 is Federal cost and $576,000 is non-Federal. The benefit-cost ratio is 2.6.

HONOLULU HARBOR (MODIFICATIONS), OAHU

Modifications to the Federal project for this principal port of the State of Hawaii (see page 5) have been authorized to meet the increased width and depth requirements of large passenger ships and the larger tankers now in use.

The authorized modifications include:

- Deepening the main entrance channel (Fort Armstrong Channel) from 40 to 45 feet.
- Easing the turn at the northeast corner of Sand Island.
- Deepening most of the main harbor basin and Kapalama Channel from 35 to 40 feet.
- Widening of Kapalama Channel by 60 feet.
- Adjusting the project harbor lines to provide 50- to 75-foot offset from the pierheads, except in Kapalama Channel and at piers 9, 10, and 11, where the offset is to be 100 feet.

The project cost is estimated at $4,500,000, of which $2,291,000 is Federal cost and $2,209,000 is non-Federal. The benefit-cost ratio for the authorized project is 5.9. Advanced engineering and design is now underway.

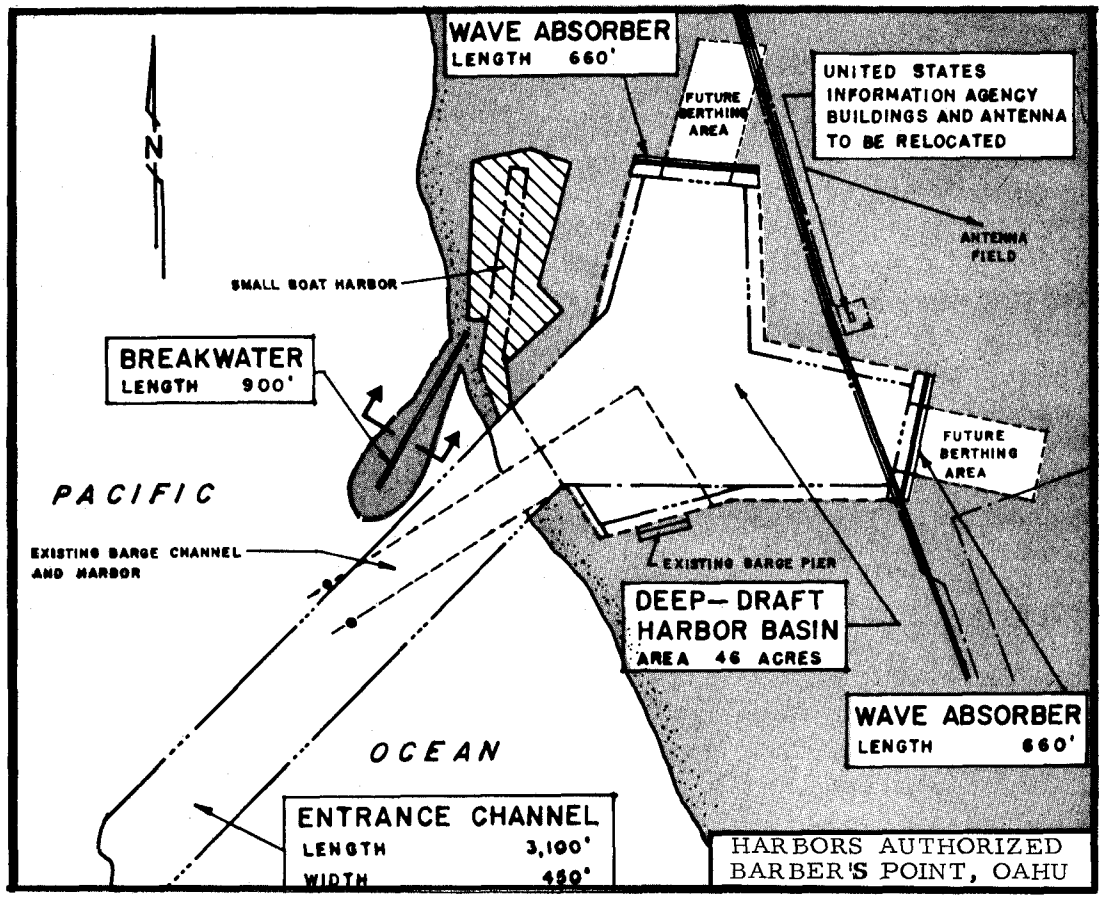
BARBER'S POINT DEEP DRAFT HARBOR, OAHU

The existing harbor constructed by local interests presently consists of a small barge basin on the leeward or west coast of Oahu about two miles north-northwest of the Barber's Point Lighthouse and sixteen miles due west of Honolulu Harbor.

The authorized plan provides for a Federal deepwater harbor (see sketch on next page) consisting of:

- An entrance channel 3,100 feet long, 450 feet wide, and 42 feet deep.
- A harbor basin of about 46 acres in area, all 38 feet deep.
- A protective 900-foot long rubblemound breakwater.
- Two segments of wave absorbers with a total length of about 1,320 feet.

The project cost is estimated at $9,140,000, of which $7,689,000 is Federal cost and $1,451,000 is non-Federal. The benefit-cost ratio for the authorized deep draft harbor is 1.7.



BARBER'S POINT SMALL BOAT HARBOR, OAHU

A small boat harbor is also authorized adjoining the deep draft harbor at Barber's Point on leeward Oahu. When completed, this harbor would accommodate about 300 small craft. The Federal portion of the project will provide a main access channel 1,200 feet long, varying from 80 to 140 feet wide, and 12 feet deep. The project cost is estimated at $196,000, of which $61,000 is Federal cost and $135,000 is non-Federal. The benefit-cost ratio is 10.5.

MAUNALUA BAY SMALL BOAT HARBOR, OAHU

Maunalua Bay harbor site is in the Koko Head area of southeast Oahu. The Federal portion of the authorized small boat harbor project will provide an east revetted mole 2,900 feet long; a west revetted mole 1,950 feet long; an entrance channel 870 feet long, 200 feet wide, 15 to 20 feet deep; and a widened channel section of 370,000 square feet, 15 feet deep. When fully developed, the harbor will accommodate about 950 small craft. The project cost is estimated at $1,188,000, of which $531,000 is Federal cost and $657,000 is non-Federal cost. The benefit-cost ratio is 4.2.

NAWILIWILI SMALL BOAT HARBOR, KAUAI

A small boat harbor has been authorized for construction within Nawiliwili Bay (page 9) on Kauai. The small boat harbor site is immediately north of the mouth of the Huleia River. When completed, the harbor will accommodate about 200 small craft. The Federal portion of the project will provide an entrance channel and main access channel having a total length of 1,600 feet, 120 feet wide, 12 feet deep; a revetted dike 954 feet long; and a revetted mole 1,380 feet long. Advanced engineering and design of this harbor has been completed, but construction has been deferred until the State of Hawaii can furnish the necessary non-Federal funds. The project cost is estimated at $394,000, of which $216,000 is Federal cost and $178,000 is non-Federal cost. The benefit-cost ratio is 2.7.

KAUNAKAKAI DEEP DRAFT HARBOR, MOLOKAI

The existing harbor at Kaunakakai, Molokai (see page 11) is not capable of handling deep draft shipping. Also, the absence of mooring and protective facilities for small boats has handicapped the growth and safety of fishing and recreational boating. As a result, deep draft and light draft harbors were authorized in 1962 for Kaunakakai.

The plan of improvement consists of:

- A new entrance channel 1,100 feet long, 500 feet wide, 40 feet deep.
- A harbor basin area of about 62 acres 35 feet deep.
- A jetty 1,000 feet long.
- A west breakwater 3,000 feet long.
- A light draft harbor with a basin area of 10 acres, 15 feet deep (see below).
- A south breakwater 2,300 feet long to protect the light draft basin and the entrance channel for the deepwater harbor.

The need for a deepwater harbor was predicated upon the installation by business of industrial facilities (a pineapple cannery) and since construction of a cannery has been indefinitely postponed, construction of a deepwater harbor has also been postponed.

KAUNAKAKAI SMALL BOAT HARBOR, MOLOKAI

In conjunction with the Federal deep draft harbor (described above) authorized in 1962, a small boat harbor was also authorized for Kaunakakai. The Federal project provides for a harbor with a basin area of 10 acres, 15 feet deep, to accommodate 250 small craft.

Construction of the deepwater harbor has been postponed, but advanced engineering and design of the small boat harbor has been completed. Construction has been deferred until the State of Hawaii can furnish the necessary non-Federal funds. Estimated project cost is $669,000, of which $383,500 is Federal cost and $285,500 is non-Federal cost. The benefit-cost ratio is 1.8.

KALAUPAPA LANDING (BARGE HARBOR), MOLOKAI

A small navigation project for Kalaupapa Harbor has been authorized under the special continuing authorities for Federal participation in the cost and modifications of the existing State of Hawaii harbor facility there. The Federal project provides for modification of the existing breakwater and dredging of a barge basin. Plans and specifications are complete and the project awaits favorable construction weather to prevail prior to advertising for construction. Estimated project cost is $254,000, of which $240,000 is Federal cost and $14,000 is non-Federal cost. The benefit-cost ratio is 2.3.

A BARGE HARBOR WILL BE CONSTRUCTED AT KALAUPAPA.

FLOOD CONTROL PROJECT UNDER DESIGN

KULIOUOU STREAM, OAHU

A Federal flood protection project has been authorized for flood control of Kuliouou Stream located in the southeast corner of Oahu.

The project is to be constructed under the special continuing authority for small flood control projects. It will provide for improvements to the existing stream channel by dredging, concrete lining of a major portion of the existing stream, modifying existing concrete rubble masonry walls, adding supplemental walls on the landward side of the existing improved channel, and construction of a 7-foot wide rectangular reinforced concrete-lined ditch to separately convey interior drainage downstream of Kalanianaole Highway. Local interest (City and County of Honolulu) is required to construct two bridges and relocate utilities. Plans and specifications are presently being prepared, and the project is expected to be under construction in the first quarter of fiscal year 1968.

Estimated project cost is $1,500,000, of which $1,000,000 is Federal cost and $500,000 is non-Federal cost.

FLOOD PROTECTION WORKS ARE UNDER DESIGN FOR KULIOUOU STREAM AND SURROUNDING RESIDENTIAL AREA.

BEACH EROSION CONTROL PROJECT UNDER DESIGN

HANAPEPE BEACH, KAUAI

Federal participation has been authorized in a beach erosion control project which will protect the publicly owned portions of Hanapepe Beach located west of the mouth of Hanapepe River on Kauai. A rubblemound seawall 1,900 feet long will be constructed by the State of Hawaii in cooperation with the Corps of Engineers. The Corps completed plans and specifications in June 1964 with funds advanced by the State. Construction by the State is deferred indefinitely as bids opened in August 1965 exceeded the total State and Federal funds available. Estimated project cost is $134,000, of which $65,000 is Federal cost and $69,000 is non-Federal cost. The benefit-cost ratio for this beach project is 2.1.

VIEW OF BEACH EROSION AT HANAPEPE BEACH.

NAVIGATION PROJECTS AUTHORIZED--NOT STARTED

REEDS BAY SMALL BOAT HARBOR, HAWAII

Reeds Bay, a small inlet in the shoreline of Hilo Bay, is within Hilo's city limits and is shoreward of the Federally maintained deep-water port of Hilo. When completed, this authorized small boat harbor will accommodate about 270 small craft. The Federal portion of the harbor will provide a breakwater 870 feet long, extending eastward from the existing shoreline to shelter a flared harbor basin of about 9 acres. There will be an entrance channel 880 feet long, 120 feet wide, and 12 feet deep. The project cost is estimated at $531,000, of which $257,000 is Federal cost and $274,000 is non-Federal cost. The benefit-cost ratio is 2.2.

HANA SMALL BOAT HARBOR, MAUI

The small town of Hana is relatively isolated on the east coast of Maui and is approximately 60 road miles from Wailuku. A small boat harbor has been authorized for construction in the northeast sector of Hana Bay to meet the needs of both small craft and commercial barges in this area. It will accommodate about 80 small craft. The Federal project will require construction of only one feature: a breakwater 1,230 feet long, of which the landward 250 feet will be a revetted mole. The structure will shelter a turning area and harbor basin of about 200,000 square feet. Depths within Hana Bay are adequate to meet the draft requirements of small craft and of commercial tugs and barges of the type expected to use the harbor. The project cost is estimated at $1,884,000, of which $1,695,000 is Federal cost and $189,000 is non-Federal cost. The benefit-cost ratio is 1.2.

LAHAINA SMALL BOAT HARBOR, MAUI

Lahaina, with a population of about 4,000, is on the west coast of Maui and about 22 road miles from Wailuku, the county seat. A small boat harbor has been authorized for construction immediately northwest of the small existing facility. When completed, it will accommodate about 160 small craft. The Federal portion of the authorized project will provide for a revetted mole 620 feet long; an offshore breakwater 950 feet long; a turning basin and main access channel of 140,000 square feet; an entrance channel 515 feet long, 150 feet wide, 15 to 20 feet deep; and a wave absorber 180 feet long. The project cost is estimated at $721,000, of which $377,000 is Federal cost and $344,000 is non-Federal cost. The benefit-cost ratio is 1.4.

HEEIA-KEA SMALL BOAT HARBOR, OAHU

The Heeia-Kea harbor site is in Kaneohe Bay on the northeast coast of Oahu. The Federal portion of the authorized project will provide 3 revetted moles with lengths of 1,450 feet, 1,780 feet, and 1,720 feet; a north access channel 570 feet long, 150 feet wide, 12 feet deep; a central access channel 1,100 feet long, 200 feet wide, 12 feet deep; a south access channel 150 feet long, 150 to 280 feet wide, 8 feet deep; with a capacity of 1600 boats when fully developed. The project cost is estimated at $851,000, of which $414,000 is Federal cost and $437,000 is non-Federal. The benefit-cost ratio is 5.5.

KAILUA SMALL BOAT HARBOR, OAHU

The harbor site is within Kawainui Swamp at the town of Kailua on windward Oahu. The Federal portion of the authorized project will provide a turning basin of 120,000 square feet, 6 feet deep; and a main access channel 1,800 feet long, 100 to 150 feet wide, 6 feet deep. When fully developed, Kailua Harbor will accommodate about 680 small craft. The project cost is estimated at $735,000, of which $250,000 is Federal cost and $485,000 is non-Federal. The benefit-cost ratio is 1.5.

WAIANAE SMALL BOAT HARBOR, OAHU

The harbor site is on the west coast of Oahu and is immediately south of Kaneilio Point near Waianae. The Federal portion of the authorized project will provide an entrance channel 820 feet long, 150 feet wide, at a depth of 15 to 17 feet; a main access channel 870 feet long, 100 to 150 feet wide, 12 to 15 feet deep; and a breakwater 1,350 feet long and a groin 175 feet long. The harbor will accommodate 380 small craft. The project is estimated to cost $1,877,000, of which $943,000 is Federal cost and $934,000 is non-Federal. The benefit-cost ratio is 1.1.

HANALEI SMALL BOAT HARBOR, KAUAI

The authorized harbor, adjacent to the mouth of the Hanalei River, will provide berthing for about 180 small craft. The plan provides for an entrance and main access channel having a total length of 1,800 feet, 100 to 120 feet wide, 12 to 15 feet deep; a jetty 380 feet long; and a 1600-foot channel and bank revetment. The estimated cost is $887,000, of which $357,000 is Federal cost and $530,000 is non-Federal. The benefit-cost ratio is 1.3.

BEACH EROSION CONTROL PROJECTS AUTHORIZED--NOT STARTED

WAIKIKI BEACH, OAHU

The authorized project will supersede the previous project and will protect the publicly owned beach extending from the Duke Kahanamoku Beach to the Elks Club in Waikiki (photograph, page 19). The plan provides for sand on two miles of beach front, new groins, and extension of existing groins; and will increase the beach area to 1,906,000 square feet. The State of Hawaii is authorized to construct the Kuhio Beach segment and receive credit therefor toward the non-Federal cost. The State appropriated $540,000 in 1963 to improve the Kuhio Beach segment, has negotiated an agreement to establish boundaries with land owners abutting this area, and plans to construct this segment in advance of Federal funding. The estimated cost of the project is $3,800,000, of which $2,490,000 is Federal cost and $1,310,000 is non-Federal cost. The benefit-cost ratio is 16.9.

WAIMEA BEACH, KAUAI

This beach is in Waimea Bay on the south coast of Kauai, and lies west of the mouth of the Waimea River and along the bay front of the town of Waimea (see photograph, page 39). Federal participation has been authorized in a joint project to protect the public shores of the beach. A rubblemound seawall 1,240 feet long will be constructed by the State of Hawaii in cooperation with the Corps of Engineers. The project has been authorized for construction; however, no work has been initiated. The estimated cost of the project is $88,000, of which $22,000 is Federal cost and $66,000 is non-Federal. The benefit-cost ratio is 1.1.

IAO STREAM, MAUI

The recommended project is the result of a survey study to consider all aspects of a multiple-purpose development and channel improvements for Iao Stream and basin on Maui. The recommended project provides for a debris basin located approximately three miles upstream from the mouth of Iao Stream, and channel improvements consisting of levees and channel enlargement, lining, and realignment through the town of Wailuku to the ocean. A multiple-purpose reservoir was found to be economically unjustified at this time. The total estimated first cost of the project is $1,900,000, of which $1,660,000 is Federal cost and $240,000 is non-Federal cost. The annual maintenance of the project to be borne by local interest is estimated at $14,500. The benefit-cost ratio is 1.3.

IAO STREAM AND VALLEY, MAUI.
(KAHULUI HARBOR IN THE BACKGROUND)

SPECIAL CONTINUING AUTHORITIES

SMALL FLOOD CONTROL PROJECTS

ISLAND OF OAHU STREAMS

Six small flood control project studies are presently underway to determine the feasibility of flood protection works under this special continuing authority on these streams on the island of Oahu:

Aiea Stream
Keaahala Stream
Waialae-Nui-Kapakahi Streams
Wailupe Stream
Waimalu Stream
Waimanalo Stream

WAILUA RIVER, KAUAI

A study under the special continuing authority for small flood control projects is underway to determine the advisability of providing flood control improvements for Wailua River on the island of Kauai. Previous studies showed that improvements along the Opaekaa and Wailua Rivers are warranted and are feasible. However, an unfavorable report was submitted in 1960 since some local interests opposed the construction of a Wailua River levee. After a deferment by local officials, the study was re-initiated in July 1965 under the small flood control projects authority, as amended. Study is presently underway to update the previous report findings on the basis of updated hydrology and economic development in the area.

FLOOD CONTROL PROJECT IS UNDER STUDY FOR WAILUA RIVER.

SMALL BEACH EROSION CONTROL PROJECTS

KAIMU, HAWAII. A preliminary study is now underway to determine the feasibility of providing beach erosion control at Kaimu near Kalapana on the island of Hawaii. A report is scheduled for completion in early 1967.

KEKAHA, KAUAI. Study is presently underway to determine the most suitable plan for shore protection at Kekaha, located in the southeast sector of Kauai. The report is scheduled for completion in early 1967.

SNAGGING AND CLEARING (NAVIGATION)

WAILOA RIVER, HAWAII. Snagging and clearing of this navigable waterway in Hilo was completed in 1958 at a cost of $42,444, and again in 1960 at a cost of $78,388. In both instances, a large amount of debris had been deposited in the river by tsunami actions.

SNAGGING AND CLEARING (FLOOD CONTROL)

IAO STREAM, MAUI. Snagging and clearing work for flood control of this stream (see page 31) was completed in 1964. The work consisted of 5,500 feet of channel improvements at a cost of $46,410.

EMERGENCY BANK PROTECTION

HAKIPUU STREAM, OAHU. Emergency work on Hakipuu Stream near the Hauula district was completed by the Corps of Engineers in 1964 at a cost of $12,700. The work consisted of repairing the stream banks to protect the bridge footings and highway.

KAALAEA-KAHULUU STREAMS, OAHU. Emergency work to restore and protect the banks adjacent to Kaalaea and Kahaluu Streams in the Kahaluu district has been approved and plans and specifications are under preparation. Construction is expected to start in the third quarter of fiscal year 1967.

EMERGENCY FLOOD CONTROL WORKS

KAPALAMA STREAM, OAHU. Repair work was accomplished on Kapalama Stream in Honolulu in 1964 at a cost of $30,044.

WAILUPE AND NIU STREAMS, OAHU. Emergency flood control work on these streams in the southeast corner of Oahu was accomplished in 1959 at a cost of $61,533.

FLOOD PLAIN INFORMATION STUDIES

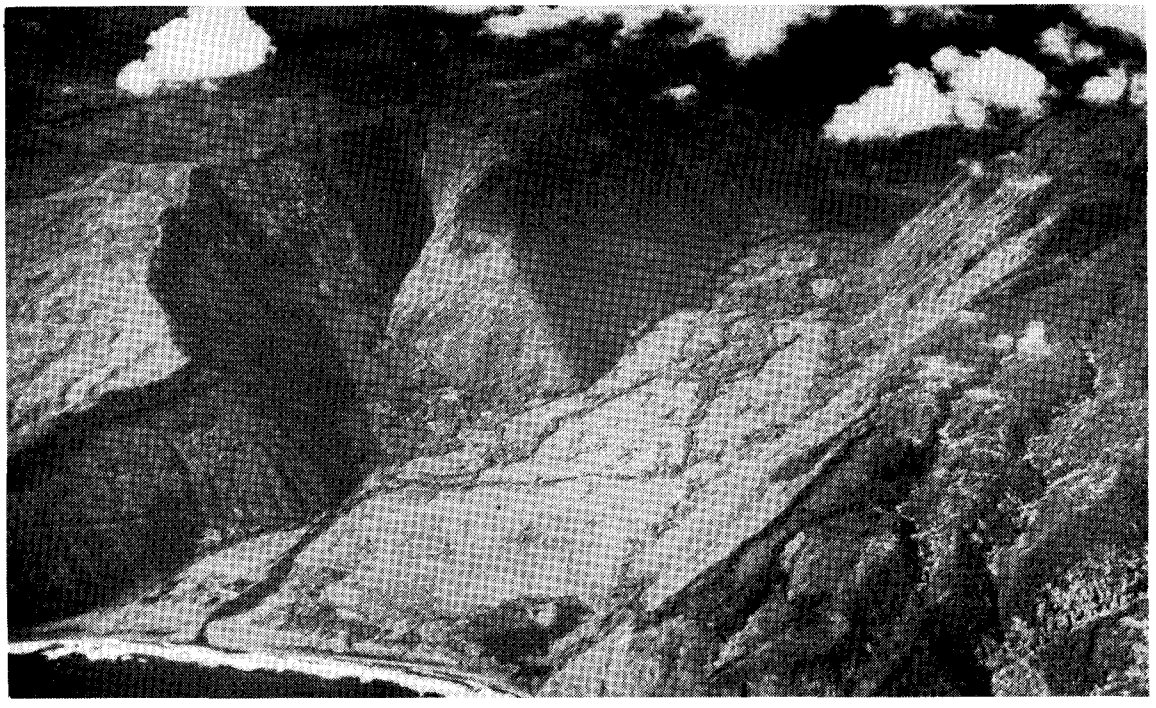
The purpose of the flood plain information studies is to disseminate information on floods and flood damages, and to identify areas subject to flooding by various magnitudes and frequencies of floods. Additionally, these studies provide general criteria for guidance in the development and use of flood plain areas.

COMPLETED STUDIES. Information studies on the following flood plain areas were undertaken at the request of the Department of Land and Natural Resources, State of Hawaii, and the completed study reports, of date indicated, are available through that agency.

KAUMANA-PUNAHOA AREA, HAWAII: February 1965
HANALEI AREA, KAUAI: December 1964
KOLOA-POIPU AREA, KAUAI: October 1966
EAST MOLOKAI AREA, MOLOKAI: January 1966

STUDIES UNDERWAY. Information studies on the following flood plain areas are fully funded and are underway.

KIHEI AREA, MAUI
PUPUKEA-PAUMALU AREA, OAHU
ANAHOLA AREA, KAUAI



BEAUTIFUL WAIPIO VALLEY ON HAWAII (see page 37).

AUTHORIZED SURVEYS

Survey investigations and reports are the origin and foundation of the authorized Civil Works (Water Resources Development) Program of the Corps of Engineers. As briefly described in the introduction to this pamphlet, such investigations must be specifically authorized by Congress. These investigations are primarily to determine the engineering and economic feasibility of adopting or modifying a Federal water resources development project.

Information pertaining to authorized investigations is presented below. Firm completion dates for investigations now underway have not been established because these surveys are dependent upon future allocation of funds.

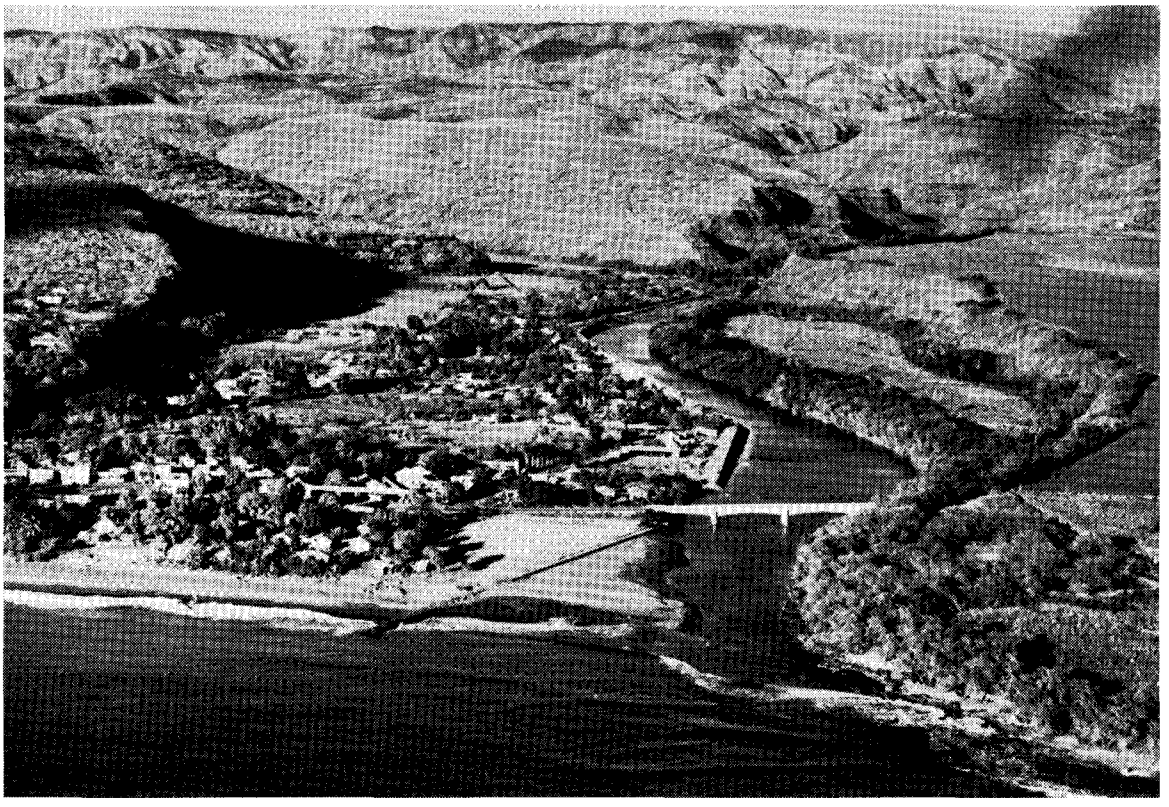
AUTHORIZED SURVEYS UNDERWAY Name of Survey and Purpose	Approximate Completion Date
NAVIGATION SURVEYS	
COASTS OF THE HAWAIIAN ISLANDS To determine the present, intermediate, and long-range need for light draft vessel harbors (including refuge harbors) and their most feasible locations throughout the State of Hawaii.	1967
1. These nine harbor projects recommended in two interim reports in 1964 have been authorized by Congress for construction: Honokahau, Kawaihae, and Reeds Bay (Hilo) on Hawaii; Hana and Lahaina on Maui; Barber's Point, Heeia-Kea, Kailua, Maunalua Bay, and Waianae on Oahu; and Hanalei on Kauai. Descriptions of the authorized projects are located elsewhere in this report (refer to index for page number).	
2. A final report is being prepared which will complete compliance with the pertinent portions of the survey authority. Modification of four existing State of Hawaii-constructed harbors to satisfy the bulk of the State's projected small craft needs to the year 2020 will be recommended in this report: Maui: Maalaea Harbor Oahu: Ala Wai Harbor and Kewalo Harbor Kauai: Kikiaola Harbor	

AUTHORIZED SURVEYS UNDERWAY Name of Survey and Purpose	Approximate Completion Date
NAVIGATION SURVEYS (Continued)	
MAALAEA DEEP DRAFT HARBOR, MAUI To determine the feasibility of a deep draft harbor for the Maalaea Area on Maui. Study was initiated in December 1965 and a public hearing was held in February 1966.	1969
PORT ALLEN, KAUAI To determine the advisability at this time of modifying the existing Federal navigation project (page 9) in any way. Study was initiated in February 1966 and a public hearing was held in April 1966. Study of the advisability of modifying Nawiliwili Deep Draft Harbor (page 38) will be combined with this study.	1968
FLOOD CONTROL SURVEYS	
KANEOHE-KAILUA AREA, OAHU To determine the advisability of providing flood protection. An unfavorable reconnaissance report under the small flood control project authority was submitted in 1965. The study indicated an economically feasible project, but the scope cost-wise greatly exceeded the Federal participation limits of the small project authority, and since local interests were unable to assume their financial responsibility they desired a Congressionally authorized study. Authority for this survey was granted and the study was initiated in December 1965. A public hearing was held in January 1966.	1969
PALOLO-MANOA STREAMS, HONOLULU, OAHU To determine the feasibility of improvements for flood control on these streams. Study was limited to the lower reaches of Palolo-Manoa Stream with emphasis on Palolo-Manoa Drainage Canal and Ala Wai Canal. The project is considered qualified for Federal participation.	1967
BEACH EROSION CONTROL SURVEY	
KIHEI DISTRICT, MAUI To determine the advisability of beach erosion protection for the Kihei District on the southeast coast of Maui.	1967

AUTHORIZED SURVEYS UNDERWAY Name of Survey and Purpose	Approximate Completion Date
MULTIPLE-PURPOSE SURVEY WAIPIO VALLEY, HAWAII To consider all aspects of multiple-purpose development and improvements of the stream and basin. (A photograph of Waipio Valley is on page 34.)	1969

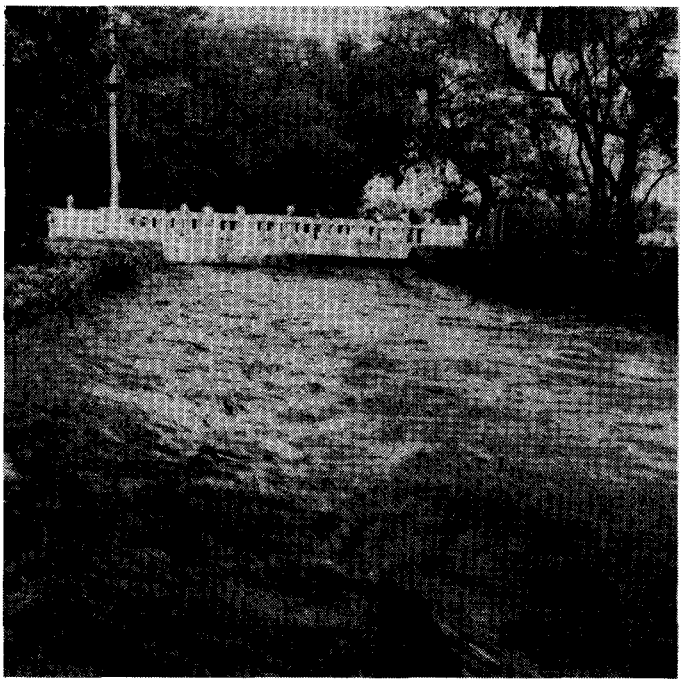
A SURVEY IS UNDERWAY TO DETERMINE FEASIBILITY OF A DEEP DRAFT HARBOR FOR THE MAALAEA AREA ON MAUI (see page 36).

AUTHORIZED SURVEYS -- NOT STARTED Name of Survey and Purpose	Approximate Completion Date
COMPREHENSIVE BASIN PLANNING	
HAWAII REGION SURVEY To determine an overall comprehensive plan for the State of Hawaii's water resources. Initiation and completion dates have not been established.	Indefinite
NAVIGATION SURVEYS	
HILO HARBOR, HAWAII To determine the advisability of enlarging the existing harbor basin and modifying the Federal project (page 1).	Indefinite
KAHALUU DEEP DRAFT HARBOR, OAHU To determine the feasibility of a deep draft harbor in Kaneohe Bay at Kahaluu on windward Oahu.	Indefinite
NAWILIWILI DEEP DRAFT HARBOR, KAUAI To determine the advisability of modifying the harbor to accommodate larger vessels. Study will be combined with the Port Allen survey (page 36).	Indefinite



THE WAIMEA-KOKEE AREA ON KAUAI.

AUTHORIZED SURVEYS--NOT STARTED Name of Survey and Purpose	Approximate Completion Date
FLOOD CONTROL SURVEYS	
KAHOMA STREAM, MAUI To determine the advisability of providing flood control works for Kahoma Stream. The original outstanding survey report will be reactivated based on findings of a study completed under the small flood control project authority (see page 40).	-----
WAIMEA RIVER, KAUAI To determine the advisability of providing flood control works for Waimea River. The completion of the survey was deferred because of renewed local interest in the Kokee Reservoir project. The Waimea River Flood Control Survey has now been combined with the Multiple-Purpose Survey of the Waimea-Kokee area (see below).	-----
MULTIPLE-PURPOSE SURVEY	
WAIMEA-KOKEE AREA, KAUAI To consider all aspects of water resource development in the Waimea-Kokee area. This report has been combined with the Hawaii Region Survey for Comprehensive Basin Planning (page 38).	-----



KAHOMA STREAM FLOOD STAGE, MAY 1960.

MISCELLANEOUS

NAVIGATION PROJECT ABANDONED

KEEHI LAGOON, OAHU. The three seaplane runways at Keehi Lagoon adjacent to the former Honolulu International Airport were constructed by the Corps of Engineers in 1944 as a wartime measure for seaplanes flying the South Pacific and for commercial use. In view of the Navy's deactivation of the existing seaplane runways and the State of Hawaii's plans for future expansion of Honolulu Harbor into the runway areas, the Federal project in Keehi Lagoon was abandoned as a Federal project by the River and Harbor Act of 1965.

NAVIGATION SURVEYS COMPLETED

EXPLOSIVE ANCHORAGE AREAS, STATE OF HAWAII. The authorized navigation survey to determine feasibility of anchorage areas or area for the safe handling of explosives in the State of Hawaii has been completed by the Corps of Engineers. A negative report was completed, and conclusions that there is no Federal interest at the most suitable site has been concurred in by the State. The report has been submitted to Congress.

LAVA CONTROL SURVEY COMPLETED

HAWAII LAVA BARRIER, HILO, HAWAII. The Corps of Engineers has completed the authorized lava control survey to determine the advisability and feasibility of providing lava barrier protection on the island of Hawaii. A negative report submitted in January 1966 was concurred in by the State. The report has been submitted to Congress.

FLOOD CONTROL STUDIES COMPLETED

KAHOMA STREAM, MAUI. A small flood control project study under the special continuing authorities was undertaken by the Corps of Engineers to determine the most suitable plan for accomplishment of flood protection works on Kahoma Stream. Information derived from this study completed in 1966 will be used in the Congressionally authorized flood control survey (page 39).

ISLAND OF OAHU STREAMS. Under the special continuing authorities, the Corps of Engineers completed studies to determine the feasibility of small flood control projects on island of Oahu streams listed below. The study reports indicated that flood protection works would be uneconomical and unfeasible under the small project authority for these streams, so negative study reports have been prepared.

MOANALUA STREAM WAILANI STREAM

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Ala Wai Yacht Harbor - Small Boat Harbor under study 35

Anahola Area - Flood Plain Information Study underway 34

Barber's Point
- Navigation (Deep Draft Harbor) Project under design 22
- Small Boat Harbor under design 23

Coasts of Hawaiian Islands - Navigation Survey
- (Light Draft Vessel and Refuge Harbor Studies) underway 35

Comprehensive Basin Planning - Hawaii Region Survey
- State of Hawaii Rivers and Harbors 38

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Explosive Anchorage Areas - Survey completed 40

Hakipuu Stream - Emergency Bank Protection completed 33

Haleiwa - Beach Erosion Control Project completed 18
- Small Boat Harbor completed 3

Hana - Small Boat Harbor authorized--not started 28

Hanalei - Flood Plain Information Study completed 34
- Small Boat Harbor authorized--not started 29

Hanapepe Beach - Beach Erosion Control Project under design 27

Hanapepe River - Flood Control Project completed 16

Hawaii Region Survey - Comprehensive Basin Planning 38

Hawaii Lava Barrier, Hilo - Lava Control Survey completed 40

Heeia-Kea - Small Boat Harbor authorized--not started 29

Hilo Harbor
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Honokahau - Small Boat Harbor under design 21

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- Navigation (Deep Draft Harbor) Project completed 5
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Kailua, Oahu - Small Boat Harbor authorized--not started 29

Kaimu Beach - Small Beach Erosion Control Project under study . . . 33

Kalaupapa Landing
Navigation (Barge Harbor) Project under design 25

Kalepolepo, Lahaina, Maalaea Area
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Kaneohe-Kailua - Flood Control Survey underway 36

Kapalama Stream - Emergency Flood Control Work completed 33

Kaumana-Punahoa - Flood Plain Information Study completed 34

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Navigation (Harbor Modifications) Project under design 20
Small Boat Harbor under design 21

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Keehi Lagoon - Navigation (Seaplane Harbor) Project abandoned . . . 40

Kewalo Basin - Small Boat Harbor under study 35

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Kihei District - Beach Erosion Control Survey underway 36

Kikiaola - Small Boat Harbor under study 35

Koloa-Poipu Area - Flood Plain Information Study completed 34

Kuliouou Stream - Small Flood Control Project under design 26

Lahaina - Small Boat Harbor authorized--not started 28

Lahaina, Kalepolepo, Maalaea Area
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Lava Barrier, Hawaii - Survey completed 40

Maalaea - Small Boat Harbor under study 35

Maalaea Bay, Kalepolepo, Lahaina Area
Navigation (Deep Draft Harbor) Survey underway 36

Manele Bay - Small Boat Harbor completed 12

Manoa-Palolo Streams - Flood Control Survey underway 37

Maunalua Bay - Small Boat Harbor under design 23

Moanalua Stream - Small Flood Control Project study completed ... 40

Nawiliwili Harbor
Navigation (Deep Draft Harbor) Project completed 9
Navigation (Harbor Modifications) Survey authorized 38
Small Boat Harbor under design 24

Palolo-Manoa Streams - Flood Control Survey underway 36

Port Allen Harbor
Navigation (Deep Draft Harbor) Project completed 10
Navigation (Harbor Modifications) Survey underway 36

Pupukea-Paumalu Area
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Reeds Bay (Hilo) - Small Boat Harbor authorized--not started 28

Waialae-Nui-Kapakahi Streams
Small Flood Control Project under study 32

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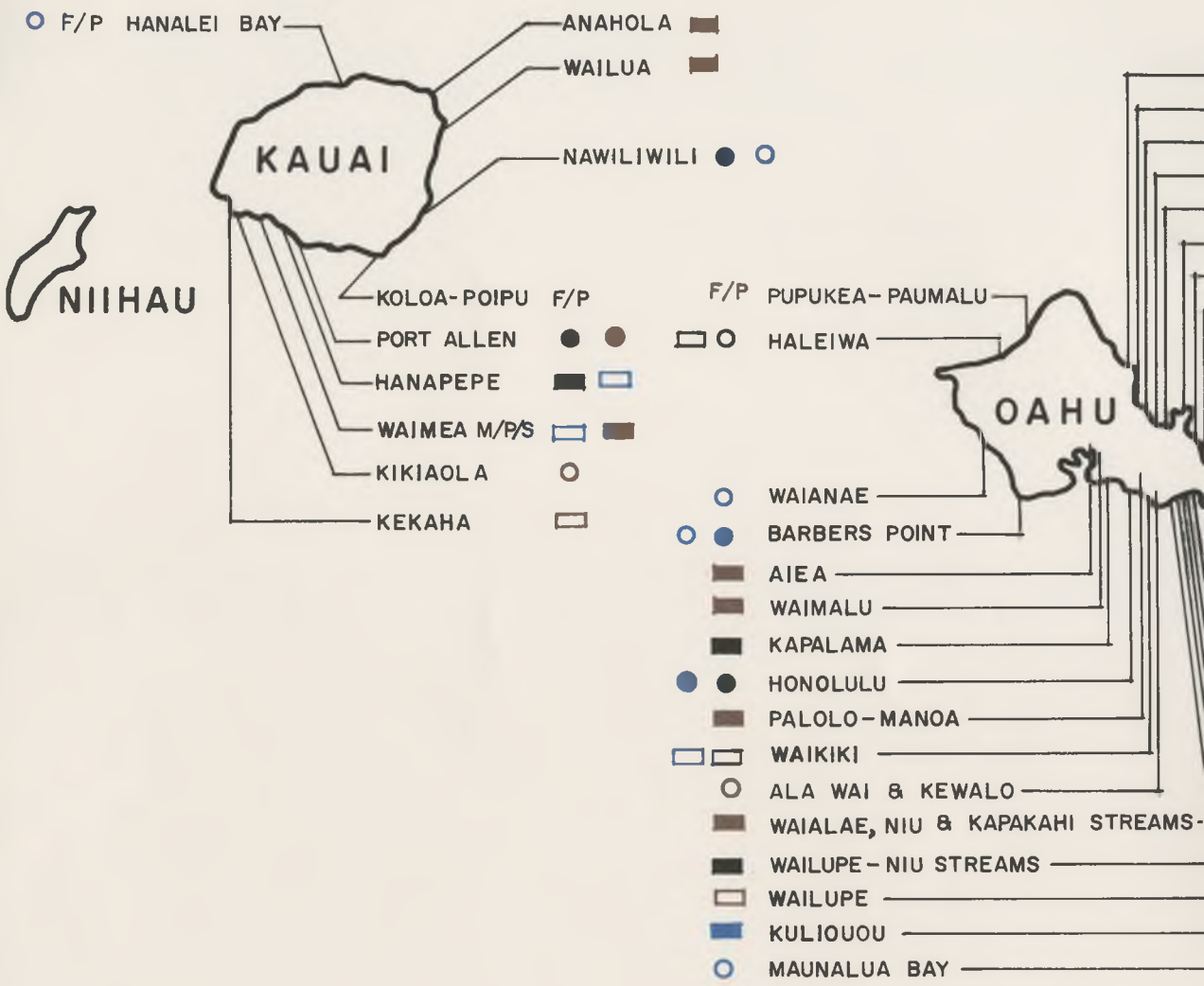
Waimea-Kokee - Multiple-Purpose Survey authorized 39
Waipio Valley - Multiple-Purpose Survey underway 37

THIS SECTION OF WORLD-FAMOUS WAIKIKI BEACH
IS DEPLETED OF SAND BY BEACH EROSION (see page 30).



PROJECT	COMPLETED	UNDER CONSTRUCTION	CONSTRUCTION AUTHORIZED	RECOM. FOR CONG. AUTH.	OUTSTANDING STUDIES
NAVIGATION					
DEEP WATER	●	●	●	●	●
LIGHT DRAFT	○	○	○	○	○
FLOOD CONTROL	▬	▬	▬	▬	▬
BEACH EROSION	▭	▭	▭	▭	▭
TSUNAMI BARRIER	△	△	△	△	△
MULTIPURPOSE STUDY				M/P/S	M/P/S
FLOOD PLAIN	F/P				F/P

JANUARY 1967

CORPS OF ENGINEERS

WATER RESOURCES DEVELOPMENT

IN THE STATE
OF
HAWAII

1967

SCALE IN NAUTICAL MILES
10 0 10 20 30 40 50 60